TWENTIETH YEAR OF PUBLICATION.

THE

JOURNAL OF SCIENCE,

AND ANNALS OF

ASTRONOMY, BIOLOGY, GEOLOGY, INDUSTRIAL ARTS, MANUFACTURES, AND TECHNOLOGY.

(MONTHLY, FORMERLY "THE QUARTERLY JOURNAL OF SCIENCE.")

Vol. V. (THIRD SERIES)
No. CXIX.

NOVEMBER
1883.

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LONDON:

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THE

JOURNAL OF SCIENCE.

NOVEMBER, 1883.

I. THE DISTRIBUTION OF COLOUR IN REPTILES, BIRDS, AND MAMMALS.

WE take the opportunity of laying before our readers some of the main results which Herr Eimer has reached in his prolonged investigations on this difficult and interesting subject. To the ordinary observer the patterns or designs recognisable in animals seem essentially lawless,—or at least appear to follow no regular, far-reaching principle. Even zoological specialists have, for the most part, come merely upon a few vague generalisations which carry us but a little way. Thus some of our correspondents have called attention to the parallel bands, at right angles, or nearly so, to the major axis of the body, which may be traced in the tiger, the zebra, and in numbers of beetles and Lepidoptera,—in the latter both in the mature and the larval condition.

Herr Eimer appears to have commenced his studies upon reptiles, and more especially upon lizards. In their manifold and seemingly arbitrary designs he has traced a strict regularity. The patterns in question are reducible to three fundamental forms—longitudinal stripes, transverse stripes, and spots. The first-mentioned of these three styles he considers as the primitive form, from which the two others have been developed by transformation, and are still undergoing changes. There are a certain number of such longitudinal stripes, occupying normal positions, and appearing as the original rudimentary starting-point of all colouration.

On every hand we find species which still display this primitive type of simple longitudinal striping. Others are spotted, and others "tigrated" (Herr Eimer's convenient

expression for transversely banded), and between these types there are the most manifold transition-forms. Not unfrequently all traces of pattern or design disappear at an earlier or later stage, leaving the animal concolorous. But even to the present day the species with higher stages of design pass through the lower stages in the course of their individual development. Thus tigrated species are in their youth spotted, and at a still earlier stage long-striped. Certain concolorous species—*e.g.*, the lion—are in youth tigrated, earlier spotted, and earlier still long-striped. Hence Eimer concludes that in primitive ages there existed only striped forms, from which other designs have gradually arisen. We have thus a new confirmation of the biogenetic law, according to which the history of the individual is an epitome of the career of its ancestry.

In these successive transformations Eimer establishes the fact that everywhere the female sex retains a more juvenile colouration than the male, thus remaining on a lower stage of development. Hence the law of "male preponderance." Eimer shows further—and this is a most interesting fact—that the transformations of design take place in a certain direction along the body. In lizards this occurs from behind forwards, so that every new property appears first at the posterior extremity of the body, extending gradually forwards, whilst the original design remains longest in the anterior parts. This rule Eimer calls the "law of undulatory development," and he traces it both in the history of the species and of the individual.

Turning from reptiles to birds, mammals, Lepidoptera and their larvæ, Herr Eimer traces the same three fundamental types of design, and the same relations. In birds, especially, the biogenetic law of colouration and the law of male preponderance are very strikingly manifest.

Young birds of allied genera or species have the same designs and the same colours, even when very distinct at maturity. The females generally retain more or less the original, youthful colouration, whilst the males of the species deviate most widely from each other in their adult stage. We may take as an instance such groups as the thrushes, or the Raptores. In these, and in many other cases, it may be observed that the plumage of the young, and of the mature hen, displays streaky spots following the direction of the length of the body. In the adult male the spots are directed transversely, or disappear altogether, this change being accompanied by a variation in colour.

These relations appear especially striking in birds of

prey. The young of almost all European species have a brown plumage, marked with black longitudinal dashes which sometimes form black lines, and are subsequently resolved into longitudinal spots. The females often retain this plumage, but sometimes in them—at least in age—it is transformed into a transverse pattern. In the male this change takes place, as a rule, on the approach of maturity. The longitudinal stripes persist longest on the under surface of the body. The back loses all pattern, and becomes concolorous, first in the male, whilst transverse stripes may remain on the lower side of the tail and the wings, or on the entire under surface. Hence the back of these birds is the first part to display new properties. Numerous instances show that here also, as with lizards, the youthful design persists longest in the anterior part of the body, whilst the new design begins at the posterior extremity and spreads headwards. Sometimes all these stages of transformation may be met with in the plumage of a single bird. Thus the throat may have long stripes, the breast longish spots, which lower down pass into a broken design of spots forming a transition to the transverse pattern, which becomes fully pronounced on the tail, whilst the back has become concolorous. The "law of undulatory development" is therefore as manifest among birds as among lizards.

Herr Eimer summarises his observations on falcons as follows:—In youth, leaving the earliest down out of consideration, as it has generally no design at all, we find a brown ground-colour and a pattern of longitudinal stripes predominate. In the female both these features persist longest, whilst new characteristics appear in the males, and especially in the elder males. The new features appearing are transverse stripes, and a grey, greyish blue, rusty brown or black colour. The transverse pattern appears earlier than the new colour. Each new stage of pattern appears first in the vigorous adult males. The forms with the more advanced characters always pass through the lower stages. The females of each form remain on a lower stage, and generally on the next lower stage than their respective males. Finally, it always appears that the new features, especially the transverse stripes, commence at the posterior extremity and advance forwards, the youthful design persisting longest at the head, whilst the upper surface is changed more rapidly than the lower.

Herr Eimer then extends his observations to the Mammalia, summarising his results as follows:—Among the mammals, also, the distribution of colour may be reduced

to long stripes, spots, and transverse bands. The longitudinal stripes are here also the pristine pattern from which spots and transverse bands proceed in turn, whilst as the ultimate stage the pattern disappears and the animal becomes concolorous. The mammalian fauna was originally striped, whilst spotty and tigrated forms appeared in succession, the same changes of design appearing in the same order of succession. Sometimes there appear only transitory intimations of the earlier types; the last is sometimes wanting; sometimes the intermediate also, and sometimes all.

The laws of male preponderance, and of the undulatory propagation of development from behind forwards, have not been so distinctly traced as in birds and reptiles. But a progressive development from below upwards is shown in this manner, that the longitudinal design persists longest in the median line of the back, often as a single stripe, whilst lower down it is resolved into spots or even transformed into bands.

In Mammalia, as well as in other animals, the transformation of the designs takes place according to fixed laws. Not even the most insignificant spot on the body is without genetic or phylogenetic signification. The persistence of the heredity of such marks is extraordinary, and thus here also the design appears a most important means for recognising the affinity of forms, and for a scientific classification.

For further details we must refer our readers to the "Jahreshefte des Vereins für Naturkunde in Würtemberg" (vol. xxxix., 1883, p. 56).

From the uniformities which he has recognised,—according to which the transformation of patterns proceeds, even to the minutest detail,—and from the circumstance that in numberless cases animals and plants produce formations in which the principle of utility can have had no immediate effect, but whose origin may be compared with that of crystals, Herr Eimer concludes that the essential principle of the conversion of forms is a development depending upon constitutional causes, and proceeding of necessity in a certain direction. The principle of utility, though important, is merely a modifying factor. The origin of new species depends, according to Eimer, upon the arrest of forms in various stages of this natural development.

II. ECONOMY OF FUEL IN HOUSE FIRES.

By T. Fletcher, F.C.S.

THE opinion expressed in the September issue of the "Journal of Science" that open fires should be renounced in favour of stoves is one not at all likely to be a general one where the cost of fuel is not excessive. Having for years in succession tested, in actual practice in my own house, nearly every possible system of heating,—by warm-air flues, hot water, close and open stoves heated by gas, coal, and coke, open fires of coke and coal, gas stoves and gas fires,—it will possibly be a matter of interest to some how the series of trials has terminated by the survival of the fittest.

The tests have been undertaken partly as a question of personal comfort and economy, and partly to obtain information for business purposes; and the latter reason has enabled me to carry out the experiments in a much more exhaustive and complete form than is likely to be done by any private individual for his own comfort.

Where a large body of air has to be heated in public rooms, plant-houses, and similar structures, there can be little doubt that hot-water pipes give the best result; and in my own experience the most satisfactory boiler is a simple coil of iron pipe, with the fire in the centre. Where equal and steady heating is required it is advisable to put in the circuit a large tank for hot water, into which all surplus heat is taken and stored. By this means, with the most irregular firing by careless and unskilled servants, the temperature of plant-houses and rooms which require to be kept aired can be controlled with perfect ease and little trouble; but to sit quietly and comfortably in rooms so heated is out of the question, apparenly for the simple reason that the temperature of the floor and lower strata of air is always lower than that of the upper parts, the consequence being cold feet and a feeling of general discomfort.

My own sitting-room—containing my private comfortable corner, special easy chair, and other matters which constitute my den, to which I retire for ease and absence of "bother"—has gone through a series of slow-combustion grates fired with coal, then with coke; grates with warm-air apparatus; grates without warm-air apparatus, supplied with fresh air from the outside, and heated with coal and

also with gas; incandescent gas-fires with supplementary warm-air apparatus to utilise the waste heat, and incandescent gas-fires utilising the radiant heat only. The round has been a pretty long one, and it has settled at the indisputable fact that radiant heat, and radiant heat alone, with the freest ventilation, is the only really comfortable and desirable way to heat a room used as a sitting-room and library.

This brings the question down to a choice of an ordinary open fire and an incandescent gas-fire, and the latter has been selected on account of the ease with which it is controlled, its instant readiness, and its total freedom from dirt. Although a complete year's work with this has not been gone through, it is evident that a room 15 × 20 feet can be comfortably and pleasantly heated with an incandescent gas-fire for about £6 per annum, with coal-gas at 3*s.* per 1000 feet, all the warm air being sent up a freely open chimney, the cost being about three times that of a coal-fire, against which may be placed saving of labour and dirt.

In the passages and bed-rooms a purely radiant heat is an expensive luxury which is not by any means necessary, or even desirable; and here we may adopt two systems:—hot-water pipes for the passages, which for economy may be heated by boilers, with a coke fire, like an ordinary greenhouse arrangement; and for the bed-rooms warm-air stoves heated by gas, which have the special advantage of being under immediate control. Why a warm-air stove should be preferred in a bed-room appears to admit of a simple explanation, *i.e.*, that the temperature of the lower strata of air and of the floor is a matter of little importance to persons in a recumbent position, the objection to this being only felt by those who are quietly sitting in a room with a low floor temperature.

I do not find that any person who has a choice between sitting in a room heated by purely radiant heat and one heated by warm air will, under any circumstances, choose the latter, even if the room itself is in other respects far more convenient and comfortable; and so long as a coal or incandescent gas-fire can be obtained at a reasonable cost, it does not appear at all likely that any stove will be adopted in ordinary sitting-rooms, whatever its apparent advantages may be.

III. SCIENCE AND SAVANTS IN MODERN LITERATURE.

SCIENCE is at last winning recognition, if not due appreciation, in a new quarter. Her results, her supposed objects, her methods, and even the personality of her followers are no longer ignored in works of fiction, though whether they are faithfully and fairly depicted is certainly open to question. This change has been of a very gradual character. In the last century there were, as we know, amateur astronomers and *dilettante* experimentalists in physics not a few. Society was deeply interested in the marvels of frictional electricity. Gentlemen of fashion turned back their ruffles in order to apply their hands as rubbers to the revolving glass globe or cylinder; and ladies, in all the glory of patches and hair-powder, discussed, or at any rate gossiped over, the results produced. Yet none of this interest was reflected in the literature of that day. Scientific discoveries and scientific theories are not even glanced at by Richardson, Fielding, Smollett, or their contemporaries. Coming down even to recent times, we may make the same remark concerning the writings of Charles Dickens. Doctors, lawyers, divines, men of erudition are introduced; but for him the investigator of Nature was too unimportant even for ridicule.

In Bulwer Lytton the case is different. Here, in "Zanoni" and in "A Strange Story," we find the search after truth put forward as a pursuit capable of absorbing human attention. But the Science of Lytton is more nearly allied to what is now becoming known as "Occultism" than to the open discipline of Western Europe. Zanoni is a physicist, a chemist, a biologist also, but the extent and the nature of his attainments are veiled over with an impenetrable cloud. He is, at at any rate, neither a picture nor a caricature of any *savant* of Lytton's own time. Nor is the knowledge which he is represented as possessing part and parcel of that which figures in our scientific journals, or in the Transactions of the great learned societies. Be it a reality or a delusion—and this is no place for discussing such a question—it is something essentially *sui generis*. Nor does it appear as a factor capable of influencing the ideas, the beliefs, and the characters of men and women of the world.

In certain modern works of fiction this step is taken :— Persons not engaged in the investigation of Nature are shown as affected by the results of research.

We are not going to deny that, especially since the great Darwinian reform, Organic Science, Biology,—or, as it was formerly called, Natural History,—is found to throw new lights upon moral, social, and political problems, and to influence the convictions of the many. As such, doubtless, it is a perfectly legitimate subject for the novelist, the dramatist, and the poet, as well as for the ethicist and the divine. But it may, we submit, be fairly demanded that the doctrines of the New Natural History, in as far as they bear upon human interests, should be correctly stated, and their influence be impartially weighed.

We must remember that Science does not *do* anything—does not bid us to do anything. Her function is merely to perceive the truth, and to make it known. If we listen carelessly, and accommodate our actions to such half-knowledge, we shall do well to lay the blame where it is due.

These remarks are suggested to us by a modern novel from the pen of a writer who is generally classed among the "sensational" school. Be this as it may, we find in it the following passage :—"He heard all that Brian had to say—he listened to his wild ramblings as to the voice of an oracle ; and then when Brian had poured out his little stock of argument in favour of Materialism, had quoted Aristotle and Holbach and Hume and Comte and Darwin, and had perverted their arguments against a personal God into the divine right of man to ruin his soul and body, John ardine, who had read more of Aristotle than Brian knew of all the metaphysicians put together, and who had Plato, Kant, and Dugald Stewart in his heart of hearts, gravely took up the strain and made mincemeat of all Mr. Wendover's philosophy."

Without any further criticism of this passage, we ask what are Darwin's "arguments against a personal God"? In what chapter of his works do they stand written? We must confess that they have never come under our notice. Nor can they have struck those eminent men who—both at Darwin's funeral and subsequently—have declared that there is in his writings nothing inconsistent with Christianity. Not a few foreign writers have expressed themselves surprised—we will not say disappointed—with the entire absence of anti-religious polemics in the "Origin of Species" and the "Descent of Man." Surely then Miss Braddon, before writing the passage above quoted, would have done

well to hesitate and enquire. As it is she has merely helped to strengthen the odium which in many quarters is still entertained against Evolutionism.

In another passage we read, as touching the same Brian Wendover, "He had just that thin smattering of modern science which enables shallow youth to make a merit of disbelief in all things beyond the limit of mathematical demonstration. He had skimmed Darwin, and spoke lightly of mankind as the latest development of time and matter, and no higher a being, from a spiritual point of view, than the first worm that wriggled in its primeval slime. He had dipped into Herbert Spencer, and talked largely of God as the Unknowable." Here, again, it may well be asked whether the denial of the traditional origin of man as a being distinct, *toto cælo*, from the rest of the animal world, legitimates the conclusion that he is, from a spiritual point of view, no higher than the first worm? All believers in Evolution maintain that man has been developed spiritually as well as physically. It is of course open to Miss Braddon to pourtray a character, like Brian, holding the views here implied; but she should have been very careful to show that the dreams and the talk of a fast young man, haunted with *delirium tremens*, are no natural consequences of a study of the writings of Darwin and Spencer.

We do not deny that in the natural sciences, as elsewhere, superficial knowledge is a dangerous thing, especially when over-rated by its possessors. To show the wrong that Miss Braddon has here done to modern science we need only ask what impression will be left by a perusal of the passages quoted? Let the book be read by a clergyman, a schoolmaster, or a parent unacquainted with Darwin's works, will he not shake his head and pronounce them most dangerous and most improper to be put into the hands of young people?

We do, however, find Darwin and his compeers presented in a somewhat different light. Concerning a certain most disagreeable young lady, and her plausible father, a duly qualified charlatan, we read:—"You remember with what a firm hand he managed her in days gone by. Well, after she took to Huxley and Darwin, and the rest of them, that was all over. She was always tripping him up with some little shred of scientific knowledge, fresh from Tyndall; always attacking his old-fashioned notions with some new light." Surely if modern research can be presented to the reader merely as furnishing a weak-minded idler with excuses for his vapid immorality, and as enabling *ci-devant*

young ladies to mystify themselves and others with half-understood incoherencies, it had better be left out of consideration altogether. Might we therefore beg novelists, if they find it necessary to notice Evolutionism, to show its true influences in the person of some working naturalist who uses it successfully as a key to the problems of the organic world? A Weissmann, a Bates, a Fritz Müller among the living, or a Balfour and a Belt among the dead, might serve as types.

There is yet another manner in which Science is made to figure in the pages of modern fiction. In the good old times when discovery, or the attempt at discovery, was a criminal offence punishable possibly with imprisonment, or even death, there were substantially no novels. Still we have no doubt that the unfortunate sages of those days were sneered at and maligned in polite society no less emphatically than they were execrated in convents and colleges. Now this is all altered: we have no longer the open persecution, but there is an organised attempt to render investigation in one important direction impossible. This movement has unfortunately met with the adhesion of not a few novelists, who are carrying on the war in a characteristic fashion. There are no substantial arguments which may be met, no alleged facts which may be proved altogether fictitious; but there are innuendoes which, falling, as they usually do, on ignorant minds, will too often take root. We need only refer to a recent tale by the editor of "Longman's Magazine," in which an attempt is made to place physiological experimentation in an odious light. How many of the multitudes who read that popular serial will know, or will care to find out, the real truth of the question? In making attacks of this kind men of Science are placed at a difficulty. We cannot issue counter-novels in which the Bestiarian agitator is shown up in his unscrupulousness, his inconsistency, his ignorance, and his mendacity. We have scarcely the funds, like our enemies, to hire light writers to plead our cause. Our pamphlets and justificatory documents, however decisive in themselves, fail to reach the persons who have read the attacks.

So far, then, Science has very little scope for congratulation on the part she is made to play in fictitious literature. She is introduced, it would seem, mainly to be misrepresented and attacked.

IV. ON THE ORIGIN OF THE CELLS OF THE HIVE BEE.

THE cell of the hive bee has for many centuries called forth the wonder of naturalists, and indeed of all observers. Why should, or how should, so comparatively humble a creature in the construction of its comb select that precise form which offers the greatest economy of form and material? Granting that the bee possesses no inconsiderable share of intelligence, we can scarcely conceive of her having made sufficient progress in the higher mathematics to select knowingly the precise angles which are best adapted to the object in view. Hence not a few writers, even to the present day, maintain that we have here a typical case of "instinct" in the old acceptation of the word,—that is, of blind, unconscious, untaught action, producing results which man can only reach by dint of highly cultivated reason. So many of these so-called instincts have lately found a scientific explanation that naturalists of the Old School have recognised the cell of the bee as one of their last entrenchments.

It is therefore very satisfactory that Herr K. Müllenhoff* has found a quite simple and satisfactory solution of the question, which neither admits of any mysterious instinct nor—on the other hand—credits the bee with the knowledge of the differential calculus.

Taking first a preliminary view of the case, we find that Pappus, fifteen hundred years ago, noted that bees constructed their cells in the form of regular six-sided columns, and proved mathematically the superiority of this shape to any other. In the last century Maraldi, and after him Réaumur, examined the form of the middle plate of the entire comb,—*i.e.*, the bottoms of the cells formed each of three rhombs. At the instigation of Réaumur the mathematician König, in 1739, found by calculation the most suitable—*i.e.*, the most economical—of all possible forms for the middle plate, and ascertained that it must consist of pyramids formed by three rhombs having at the apex the angle 109° 28′. Maraldi had found this as the very angle actually employed by the bees.

* Naturforscher und Berlin Entomolog. Zeitschrift.

These investigators show that each cell represents a six-sided column, bounded at the middle plate of the comb by a three-sided pyramid; the edges meeting at the deepest point of the cell form angles of 109° 28′; other angles of the same magnitude are enclosed by the short side of the hexagonal column and the two adjacent sides of the rhombs. In the terminal points of the long sides of the prism there meet, therefore, four edges at angles of 70° 32′. The arrangement of the wax plates which compose the entire comb may therefore be formulated as follows:—1. On one edge there intersect each other each time three films, and these form with each other equal angles of 120°. 2. At the terminal points of the short sides of the prism meet in each case four edges at angles of 109° 28′. 3. In the terminal points of the long sides of the prism four edges cut each other at 70° 32′.

These properties correspond almost exactly with the laws which Plateau has discovered for his equilibrium figures,—namely, at a liquid edge there intersect each other never more than three films, and these form with each other equal angles, and when liquid edges intersect each other in the interior of the figure they are always four in number, and form with each other equal angles.

Cells of exactly the same arrangement and the same angles as the cells of bees are obtained if numerous soap-bubbles of equal size are suspended in two parallel frames, and if the two systems of bubbles are approached until they touch each other. The soap-bubbles flatten themselves and form hexagonal prisms, terminating in Maraldi's pyramids, at the meeting-points of the two systems. The uppermost row of bubbles (that attached to the frame) would take the form of five-sided pyramids,—*i.e.*, the exact form of the cells which are attached to the woodwork.

The conclusion is, therefore, very natural that this absolute agreement in the respective forms of the soap-bubbles and of the bees' cells depends on similar physical conditions in the construction of both.

If we observe the bees when building their comb, we find that, underneath the board to which it is attached, at least a dozen bees are clinging on each side, in such a manner that the heads of the bees on one side of the comb are exactly opposite to those on the other. As each bee, holding a ball of wax in its jaws, presses as far as possible upwards and forwards, the ball is converted into a plate by the pressure from both sides. At first this plate is not level, but is bent up and down corresponding to the pressure of the numerous heads of the bees.

As the bees press forwards the heads, as they meet, must always make way for each other in the direction of the least resistance,—that is, in a newly-begun comb a bee on one side is pressed downwards by its two competitors so as to come with its head exactly in the middle between three who stand opposite. As each bee on the one side presses with its head into the space between the three coming to meet her there is formed, by the pressure to which the soft wax is exposed, the middle plate so much admired on account of its "highest purposiveness." The pyramids of Maraldi are merely Plateau's equilibrium figures extended between the terminations of the sides of the prisms just commenced!

The "instinct" which the bees display is very simple; they press on with their wax upwards and forwards in two perpendicular layers. Of a skilful treatment of the wax there is no trace. The Maraldi pyramids are formed purely on physical principles, not by the conscious activity of the architects. The form of the head of the bee has no meaning as far as the shape of the bottom of the cell is concerned, since, in consequence of the high temperature produced by the respiration of the bees and the continual pressure, the wax is plastic in a high degree.

In an analogous manner the sides of the prism are also produced by the pressure which the cylindrical body of each bee undergoes from the six bees arranged around her on the same side of the comb. The process is exactly as when cylinders of equal thickness are formed into six-sided prisms by an equal pressure.

It appears that the procedure of each single bee is exactly the same as if she wished to construct a hollow cylinder. In fact, if we give them a thick cake of wax they bite and press in it round holes. When they work with an excess of material, as is often the case in the cells of drones, each single cell is a cylinder with a hemispherical bottom. If in such cells, which resemble test-tubes, the excessive substance is removed, the walls both of the prisms and the pyramids gradually take the usual form.

On an examination of a royal cell it appears, also, that the individual bee understands merely how to construct a hollow cylinder with a hemispherical depression at the end.

The fact that the bees frequently, and without any perceptible order, gnaw holes into the outer wall of the thick mass of wax of a royal cell, which naturally turn out hemispherical as the counter-pressure on the opposite side is wanting, shows that their artistic skill does not take a high rank.

When the cells are filled with honey, or with full-grown larvæ, they are hermetically closed with a lid of wax. The covered cell has then, as appears from numerous measurements, the exact form of the soap-bubbles above mentioned. The cells of the *Melipona* and those of single combs are also quite similar to soap-bubbles. The detached "honey-pots" of the *Melipona* are globular, like a freely suspended bubble. If two such cells touch each other they become flattened at the point of contact. Three such cells, if sufficiently close together, take such a form that their planes of contact intersect each other at an angle of 120°. If numerous soap-bubbles, of equal magnitude, are arranged in a single plane. they approach the form of wasps' cells. The phenomena of cohesion in the paper of wasps' nests differ entirely from those of water and of wax, and produce a dome-shaped cell-bottom and cover. If a stratum of soap-bubbles is suspended vertically, and is brought in contact with a second similar stratum, the form of the ordinary double comb of the hive bee is produced. The agency in the formation of these kinds of cells is to be sought not in a skilful movement of the jaws of the insects, but exclusively in physical causes. These are, in the case of wax, that the plastic and viscous material—just as is the case in soap-bubbles—gives way until a given space is enclosed by a minimum of surface. Hence planes are formed like those of Plateau's equilibrium figures.

The shape of the cells can no more be sought in the bodily structure of the bees than in their architectural skill. In view of the plastic character of the material and the manifold impulse to change of form connected with life in the hive, the cells must soon, if equally arranged, take the form of six-sided prisms terminated by Maraldi's pyramids, even if the bees had globular or conical bodies.

Here Müllenhoff is rather inclined to assume that the general bodily form of the *Melipona*, the bee, and the wasp, has been modified by the arrangement of their cells.

V. "PROGRESS" FROM AN EVOLUTIONIST POINT OF VIEW.

By Frank Fernseed.

IF once we recognise that the forms of organic life, such as we now find them, have originated by a succession of gradual changes, we cannot fail to be struck with certain analogies between the origin of species and the rise and growth of human society. Social and political thinkers have by no means overlooked this consideration; but they have for the most part erred from an insufficient acquaintance with Evolution, or rather Transformation, as it exists in the animal and vegetable world. Setting out from such imperfect knowledge they have assumed that change may be traced everywhere; that such change is always from an inferior to a superior condition, and that it can or may take place in one direction. These notions, more or less distinctly formulated, are involved in the idea of "progress" as we find it put forward in speeches and sermons, in leading articles, and even in independent works. Unfortunately these views are flatly contrary to the analogies of Nature, and are hence misleading in speculation as in practice. If we make even a moderately careful inspection of the world around us,—such an examination as may be fairly demanded from an educated non-specialist,—we find, on the contrary:

1. That the general truth of Evolutionism, notwithstanding change, is not a universal law of Nature.
2. That where changes occur they are not always serial, moving on in some given direction, but cyclical or periodic, returning to their original starting-point.
3. That where change or transformation shows no appearance of returning upon itself, it is not always from a lower to a higher grade, but frequently in the very opposite direction.
4. That changes, be they for the better or the worse, are not necessarily in one direction only, like the prolongation of a line chalked upon a board, but may take ramifying courses like the branches of a tree.

These four points we will endeavour to unfold and illustrate, pointing very briefly to the practical conclusions which each necessitates.

1. In many respects the scientific inquirer finds not change, but permanence, to be the manifest law of the universe. The expression "Constants of Nature" has already become stereotyped. If we examine the atomic weights, or the specific gravities, or indeed generally the physical and the chemical properties of the different kinds of matter, we find them unchanging. From no fact known, from no circumstance suspected, or even conceivable, have we ground for doubting that the attributes of pure iron, or gold, or sulphur, were in the slightest degree other ten million years ago than what they are at present, or than what they will be ten million years hence. Here then is permanence, not progress, on a vast scale and in matters of grave importance.

But even in the world of life change is not universal. Species, indeed, have sprung into existence, and have passed again away, leaving merely their imprints in the "great stone book." But other forms which flourished in remote geological ages have not thus passed away, but still survive. To resist change, or the impulse to change, is therefore not *per se* a struggle against Nature.

2. We have said that change, transformation, where it occurs, is often cyclical. Instances of such change are almost too common, too familiar to need or even to permit of especial mention. All the variations of the seasons, all the changes of climate which we experience when traversing the earth's surface, are of this character. By going on we merely return to where we set out. But periodic change is the essence of individual development. The young animal passes through a series of changes, which may be described as a movement in the direction of perfection. It increases in size and strength; its various organs are matured, and become capable of exercising their functions; its individuation as compared with the outer world is complete, and then ——? There follows a gradual decay in every respect, as was expressed by the old moralists when they compared the life of a man to a day or to a year. Be it noted that when once maturity is reached in the life of the individual it becomes his object, if desirous to make the best of life, to resist, or at least to retard, that series of transformations —certainly not to accelerate or force them on—the last term of which is death. The judicious man, when once he has reached the end of his "golden decade," husbands his strength, avoids every outlay of vital force for purposes of small moment. Nay, we may go much further, though it

would be suicidal and decidedly criminal to check or traverse natural development in the earlier portion of life, yet no judicious, conscientious parent or educator seeks to hasten on the natural series of transformations. To foster in the child the thoughts of the youth, or to demand from the latter the deeds and endurances of the man, is a capital error. One of the deadliest sins of the modern organisation of society is that it sends young people to the workshop and the counting-house when they ought to be at school, and in return grinds them in "standards" when they should be at play.

Proceeding from these analogies we may well ask whether in human communities, or in human society altogether, there does not come a time when change, if it occurs at all, is not regress rather than progress? Whether it does not become good policy to resist, or at least retard, such changes instead of stimulating and urging them on? Perhaps the essential principle of vigorous individual life may be looked upon as a kind of cohesive impulse which holds all the parts of the animal together in intense sympathy. As life decays this is no longer the case; individual unity, as contrasted with the outer world, grows feebler; injuries are less promptly repaired, and at last the system ceases to be a unity and is resolved into the general mass of matter, undistinguished and undistinguishable.

Very similar is the course of things in a human community: in its earlier days there is intense vitality or individuation pervading the whole; gradually, as maturity is reached and passed over, this principle, which is known in a community as tribal instinct or patriotism, fades away; its different members feel less and less mutual attraction, and finally reach, in cosmopolitanism, a state closely analogous to the decomposition of the animal body and its cessation to exist as an individual.

We find that the de-individualisation of the animal or plant is effected, or at least greatly accelerated, by certain microbia which set up in its tissues fermentations,—in other words, disease processes. If such germs have any degree of consciousness—and it might be unsafe to deny this altogether—they may possibly believe that they are doing an exalted and noble work, and leading the body which is the seat of their operations to a higher vitality. Are there not, in like manner, social bacilli, disease-germs which set up fermentations—*i.e.*, agitations—in communities, and lead the body-corporate in the same path of decomposition? It is to be remarked that certain advanced thinkers on social

questions openly maintain that where the rights or the interests of the individual man come in collision with those of the community, the latter must give way. They sacrifice thus the complete animal to some cellule of its body, encouraging in the latter a mutinous local vitality,—a disease process. How utterly different is this procedure from the order of Nature! She sacrifices with little scruple numberless individuals in her attempts to raise the type. They, fancying perhaps all the while that they are obeying her guidance, are ever ready to damage community, race, species itself, for the convenience of the individual.

3. The commonest error on the subject of "progress" is the supposition—tacit, if not stated in so many words—that every change, every departure from what at present exists, must be for the better.

Leaving out of sight those transformations, already noticed, which in the individual lead to death, we find innumerable instances to the contrary, both in the early life of individuals and still more in the career of species. Degeneration, as has been shown by Prof. E. Ray Lankester, and by Prof. Dohrn, of Naples, has played a very marked part in the genesis of species as we now have them. Thus almost all the parasites, external or internal, are degraded forms whose forefathers, more highly organised, once led an independent existence. Thus the various species of lice are supposed, on good grounds, to have once been hemipterous insects whose wings have become abortive, and whose structure has in other respects grown ruder and lower. The fleas are in the same manner degenerated Diptera.

The parasitic group of Crustaceans commonly known as Epizoa are in their earlier stage capable of locomotion, and possess eyes and antennæ. When mature they lose their organs of motion and sensation, and become permanently attached to the skin of fishes, &c. Here, therefore, the mature animal is lower, simpler than it was in the larval condition.

Even in species which perhaps upon the whole are higher than were their remote forefathers, some organs are generally found to be in a degenerated condition.

Thus Nature continually gives the lie to the assumption that all change is in an upward, forward direction. Her transformations sometimes end in converting an active sensitive creature into a "barnacle,"—ridiculed by those who do not know its life-history as the very type of "stand-stillism" and anti-progress!

There is here at hand another consideration which must not be overlooked. In turning over the evidences of extinct faunas we often come upon the traces of some highly-specialised animal group, strong, fierce, formidably armed, and possessing as it might seem every attribute needful for success in the great struggle for existence, and for transmitting its descendants down to the present day. Such a group, for instance, was that of the Machairodon, or sabre-toothed tiger,—a form including several species, distributed over North America, Europe, India, and probably over other parts of the globe. Yet it has "died and left no sign." No Machairodon survives, nor yet any Carnivore which can trace its descent to this terrible monster. The dominant forms of the present day seem to have sprung from species less powerful and less specially endowed for a life of rapine. The principle involved in these facts has been embodied by Prof. Cope in the "doctrine of the non-specialised." The meaning of this doctrine may, we think, be gathered from the case of the Machairodon. The ascending line of development proceeds not from the more specialised forms who at their time seem the highest beings in existence, and qualified to become the progenitors of still superior types in the future, but from some species or group of species of less striking attributes and of a more generalised character. The suggestion has been thrown out, we believe, by Prof. Cope himself, that the same principle may be traced in the career of human communities. If we take a survey of the world at intervals of say a thousand years, we shall find that not only nations, but races, occupy a very different position at any such survey from what the former survey would have led us to expect. Who, for instance, looking a thousand years ago upon that race which is conventionally called the Anglo-Saxon, would have ventured to give a forecast of the part which it has since played in the history of the world. But, according to this same doctrine of the non-specialised, the hegemony of the civilised world a thousand years hence will not remain with this race, probably even not with any branch of the Teutonic stock, but will have fallen into very different hands, which it would be out of place here to indicate.

4. The last error of the orators and writers of "progress" is taken from a false analogy. They liken humanity, not to a growing tree, sending out branches in various directions, but to a traveller marching along a road, who must either come to a stand or go on in one given direction. That

direction is of course determined by the wishes or the whims of the speaker. If you do not fall in with his ideas and projects you are liable to be denounced as one who wishes to arrest progress, "already slow enough," and you are, in somewhat stale figures, likened to the Mrs. Partington of modern mythology. Yet perhaps that particular "progress" you seek to arrest may be but the rogue's march to the gallows, the sick man's approach to dissolution.

Such are some of the considerations which suggest themselves if we seek to apply the principles of Evolutionism—perhaps we had better say of "Transformism," inelegant as is the word—to a survey of the present position and future prospects of society and of societies. We would recommend social, moral, and political thinkers to familiarise themselves more thoroughly than they have hitherto done with these principles. Perhaps they may find occasion to reconsider certain of the dogmas in which they most delight.

VI. OUR ANIMAL ENEMIES AND ALLIES RECONSIDERED.

SCANTY as is the British fauna, our knowledge of its relation to human needs and conveniences is by no means complete. Almost every season we notice fresh features in the habits and character of some apparently well-known species which must be taken into account when the question of its preservation or destruction has to be raised. In such cases we cannot help asking whether our forefathers have merely omitted to record some old fact, or whether the species in question are developing new habits? On this point no general law can be laid down. We know that changes of diet have been distinctly traced, as in the New Zealand parrot and the South African baboon, both of which have quite recently acquired a taste for mutton. In like manner, if we turn over the zoological literature of the past, we find the common squirrel invariably spoken of as perfectly harmless, living upon nuts and acorns. Yet if we

consult modern gardeners whose lot has been cast in well-wooded districts, or if, better still, we contrive to make observations in person in such a neighbourhood, we shall find cause to regard this elegant little animal as a tree-rat, meriting little toleration at our hands. He now varies his traditional diet with wall-fruit, and occasionally with pears and apples, carefully selecting the finest specimens. His depredations of this kind are not mere matter of conjecture; again and again, in the stillness of an early summer morning, he has been watched in the very act of gnawing peaches. The marks of his teeth in pears, &c., are also quite distinct from the peckings of birds.

But there is another charge against the squirrel: in shrubberies undisturbed by human depredators we may one day observe a bird sitting peacefully upon her eggs; the next day we find the nest all pulled to pieces, the eggs gone, and the parent-birds flown to seek some safer spot. This mischief is also due to the squirrel. Accordingly, if one of these buff-coloured rodents makes his appearance in a grove during nesting time, the alarm and dismay of the birds is almost as striking as if a hawk were seen hovering overhead or a weasel were running up the tree. Egg-eating appears to be distinctly one of the squirrel's modern accomplishments. Whether he confines his attacks to the nests of tree-haunting species, or occasionally indulges in a raid upon the eggs of the partridge and the pheasant, we cannot say with certainty. Still, from certain suspicious facts, we should commend him to the jealous scrutiny of the gamekeeper.

As far as the smaller birds are concerned, however, not merely the eggs but the callow young are exposed to the attacks of Bunny. Hence, for our part, we feel no hesitation in signing his general death-warrant.

But to find a means for carrying out the sentence is difficult. It is rarely possible to get a fair shot at him if he knows that you are in pursuit, as he dexterously contrives to keep the stem of a tree or a thick branch between himself and the source of danger. Sometimes in the twilight of a summer evening a family party of squirrels will come down to have a dance on the lawn, and may then be struck down if a loaded gun is at hand. In his early morning raids in the garden, too, he sometimes may be found within range in the open. Dogs and cats pursue him, but they are almost equally inefficient. We think, indeed, that a cat has more chance of catching a bird than a squirrel.

As for his wild enemies, the weasel and the polecat—which occasionally surprise him in his nest by night or in

his winter-retreats—cannot be encouraged where poultry or game are being reared. The same objection applies to the carrion crow, the raven, and to certain hawks. The larger owls are probably his best and most trustworthy opponents, and should from a variety of grounds be preserved and encouraged. Much might be done towards the extirpation of the squirrel by careful search during the winter in the hollows of trees. How is it that no one has yet devised a squirrel-trap?

Passing from Mammalia to birds, we are sorry to find that not a few are far from improving on a closer acquaintance. The number of purely zoophagous species which do not admit more or less vegetable matter—seeds, fruits. &c.—into their dietary is not large. We may even ask whether among those birds which remain with us throughout the year there are, save the birds of prey, commonly so called, any purely zoophagous forms? In a severe winter the supply of insects, worms, slugs, &c., is often interrupted for so long a time that a bird incapable of digesting seeds, berries, &c., would be in great peril of starvation.

Among the more useful wild birds the starling has long held high rank as a vermin-destroyer. The German farmers from time immemorial have been in the habit of fixing up small boxes in their orchards, in which this bird may build its nest, secure from cats, hawks, owls, &c. We have often heard the opinion expressed, by intelligent and observant men, that the protection thus afforded to the starling was well remunerated. Nevertheless everyone must have seen this bird feasting upon the red currants in our gardens, and have heard it protest with angry screams when the fruit is being gathered and carried away.

The jay, as a member of the same group, the Corvidæ, by repute zoophagous, is for the most part denounced—mainly by game-preservers—as a suspected destroyer of the eggs of pheasants and partridges, and defended by lovers of birds as an eradicator of caterpillars and other noxious insect-larvæ. It may be, however, that his main disservices to man are to be witnessed in the orchard and the kitchen-garden rather than in the game-preserve. The skill with which he extracts peas and beans from the pod, leaving it apparently intact until it collapses on handling, is worth notice. The scarlet-runner and the kidney bean do not seem to meet his taste at any stage of their growth. Gooseberries the bird attacks in a similar style, making a small opening with the point of his beak, sucking out the pulp, and leaving the empty skin hanging. The jay is decidedly a neat feeder.

Whether his good deeds among cockchaffers, Elaters, and noxious larvæ fairly compensate his work among various crops is hard to decide.

The thrush group, as it has been often pointed out, hold also an ambiguous position. Did they merely take "a little fruit"—as certain writers euphemistically express it—they might live in our good graces. But where they are plentiful and have been fed through the winter they display their gratitude by taking "not some, but all." Long before the crop is ripe they make numerous trial borings, never finishing a fruit. The damage thus begun is carried on by wasps, flies, earwigs, &c., and by rain, and the fruit in consequence rots before it can ripen. Scarecrows, however cunningly devised, lose their terrors in at most three or four days. Nets are not easily applied to standard trees, and are in any case certain to keep off an appreciable portion of the sunshine, rarely too abundant in Britain.

Last and worst of the feathered race comes the sparrow. Not, indeed, that a particle of evidence has turned up in his favour. All the intelligence that comes to hand from countries where he has been indiscreetly acclimatised—*e.g.*, the United States—points in one and the same direction. Careful observers there have not merely watched closely the doings, the goings, and comings of the sparrow, but have from time to time shot a specimen, and opening his crop made an examination of its contents. The result has been most condemnatory: three-fourths at least of the food of the sparrow are in this manner proved to consist not of caterpillars, gnats, and the like, but of fruit, grain, and other matter which man preserves to reserve for his own consumption. We can pronounce this bird, therefore, frugivorous from choice and occasionally insectivorous from necessity, with a general tendency to mischief. Thus one observer, finding the sparrows apparently hard at work in some vines, left them for a time unmolested, in the belief that they were ridding the vines of some injurious insect. On closer examination he found that they were biting off the fruit-buds, eating, however, little of what they thus destroyed, but throwing the fragments to the ground in superfluity of naughtiness. The owner's prospect of a crop of grapes for the season was thus effectually cut off.

Another sin of the sparrow is manifested as strikingly in America as in Europe,—the war, too often successful, which it wages against the harmless and useful swallow. The helpless young swallows are often dragged from the nest and thrown to the ground, and the parent birds, on their return,

find the hateful enemy in possession. We fear, from a variety of facts which come under our notice, that the swallow and the martin are becoming decidedly less abundant in Britain, and that this decrease is owing in great part to the increase of the sparrow. We know an instance of a mansion in Essex, standing in its own grounds of about 80 acres, where the swallows were till lately very numerous. They were considered by the proprietor and his family as most welcome visitants, since the neighbourhood is in summer much infested with gnats and midges. But though protected from all ordinary forms of molestation they have gradually become less and less numerous, and this year, if we remember rightly, none at all have put in an appearance. In former seasons it has repeatedly happened that their young brood has been thrown down by the sparrows, and more than once an intruding hen sparrow has suffered death on being caught in a swallow's nest.

Now if we remember that gnats are found to be not a mere irritation or annoyance, but conveyers of disease, the preservation of the swallow and of every gnat-destroyer becomes a point of sanitary policy, and is consequently a national concern. The question therefore arises whether a war of extirpation against the sparrow should not be undertaken in a more general and systematic manner than has heretofore been the case.

Turning from birds to Batrachians we find a shade of doubt attaching to the toad,—an animal which we have hitherto regarded as an unimpeachable friend. His services against slugs, wood-lice, and a number of garden-pests, are generally recognised. But we have heard it latterly asserted, by persons whose evidence is entitled to some respect, that he has been seen in the very act of devouring strawberries. We by no means consider the proof sufficient, and hope that our sober friend may yet be found entitled to an honourable acquittal. But we recommend close observation during the ensuing season. Nothing short of being seen in the very act ought to suffice, since a bitten strawberry may be, and generally is, the work of snails or slugs. All our knowledge, indeed, concerning the habits of the toad and his allies militates plainly against his proving to be a fruit-eater, but we have had abundant proof that the habits of animals often differ strikingly from what their structure and their affinities seem to warrant.

Concerning noisome and destructive insects there is this season but little to remark. The crane-fly, or daddy long-legs (*Tipula oleracea*), has been found in many parts of

England in almost unexampled numbers; so that, unless its eggs and larvæ meet with some destroying agent before the spring, there is every reason to fear that the grass and the corn must suffer heavily. The slaughter made among this enemy by birds, spiders, &c., seemed quite a vanishing quantity when compared with the millions remaining.

The house-fly has been in many places less abundant than usual. We have even met with persons ill-informed or injudicious enough to consider this scarcity an evil omen in a sanitary point of view.

The blowfly appears to have an especial fondness for ivy-blossom,—a tendency not easy to understand, since the ivy certainly gives off no odour at all similar to that of tainted meat.

Wasps have been locally plentiful, and very destructive to fruit. Their nests are now preferably attacked by means of petroleum. The exact position is marked in the day-time, and after nightfall the nest is drenched with half a gallon of petroleum, more or less according to size, and ignited either by means of a match or by firing a blank cartridge into the mass. This method is far safer and more efficient than the old methods of digging out, blowing up with gunpowder, &c. We now think that the extirpation of wasps may be undertaken with little scruple, since the chief service which they render, the destruction of blowflies, can be better effected by other methods. In the fertilisation of flowers wasps play but a very subordinate part.

Earwigs have been unusually scarce, as far as we have been able to observe, and the gooseberry caterpillar and moth (*Abraxas grossulariata*) has in many gardens been totally absent.

Altogether insects of all the orders have been exceptionally scarce,—a fact ascribed by some to the extremely damp character of the last winter, when many larvæ, and especially pupæ, must have become mouldy.

On recapitulating the above facts we cannot help seeing that the old absolute distinction made between the "carnivorous" and "herbivorous" animals is, like most such dualistic classifications, no longer tenable. With the great exception of the ruminant group, whose highly specialised digestive organs are adapted to deal with huge quantities of a sparingly nutritious matter, the majority of mammals are omnivorous, capable of adapting themselves either to an animal or a vegetable diet, or to a mixture of

both. This conclusion is not merely fatal to one of the dogmas of the Old Natural History, but militates against the fundamental principles of the Vegetarian movement.

VII. A PLEA FOR PURE SCIENCE.*

By Prof. H. A. Rowland.†

THE question is sometimes asked us as to the time of year we like the best. To my mind the spring is the most delightful; for Nature then recovers from the apathy of winter, and stirs herself to renewed life. The leaves grow, and the buds open, with a suggestion of vigour delightful to behold, and we revel in this ever-renewed life of Nature. But this cannot always last. The leaves reach their limit; the buds open to the full, and pass away. Then we begin to ask ourselves whether all this display has been in vain, or whether it has led to a bountiful harvest.

So this magnificent country of ours has rivalled the vigour of spring in its growth. Forests have been levelled, and cities built, and a large and powerful nation has been created on the face of the earth. We are proud of our advancement. We are proud of such cities as this, founded in a day upon a spot over which, but a few years since, the red man hunted the buffalo. But we must remember that this is only the spring of our country. Our glance must not be backward; for however beautiful leaves and blossoms are, and however marvellous their rapid increase, they are but leaves and blossoms after all. Rather should we look forward to discover what will be the outcome of all this, and what the chance of harvest. For if we do this in time we may discover the worm which threatens the ripe fruit, or the barren spot where the harvest is withering for want of water.

I am required to address the so-called physical section of

* In using the word "Science," I refer to physical science, as I know nothing of natural science. Probably my remarks will, however, apply to both, but I do not know.

† An Address delivered before Section B (Physics), American Association for the Advancement of Science. Minneapolis, 1883.

this Association. Fain would I speak pleasant words to you on this subject; fain would I recount to you the progress made in this subject by my countrymen, and their noble efforts to understand the order of the universe. But I go out to gather the grain ripe to the harvest, and I find only tares. Here and there a noble head of grain rises above the weeds; but so few are they that I find the majority of my countrymen know them not, but think that they have a waving harvest, while it is only one of weeds after all. American science is a thing of the future, and not of the present or past; and the proper course of one in my position is to consider what must be done to create a science of physics in this country, rather than to call telegraphs, electric lights, and such conveniences, by the name of Science. I do not wish to underrate the value of all these things; the progress of the world depends on them, and he is to be honoured who cultivates them successfully. So also the cook who invents a new and palatable dish for the table benefits the world to a certain degree; yet we do not dignify him by the name of a chemist. And yet it is not an uncommon thing, especially in American newspapers, to have the *applications* of Science confounded with Pure Science; and some obscure American who steals the ideas of some great mind of the past, and enriches himself by the application of the same to domestic uses, is often lauded above the great originator of the idea, who might have worked out hundreds of such applications had his mind possessed the necessary element of vulgarity. I have often been asked which was the more important to the world, pure or applied science? To have the applications of a science, the science itself must exist. Should we stop its progress, and attend only to its applications, we should soon degenerate into a people like the Chinese, who have made no progress for generations, because they have been satisfied with the applications of Science, and have never sought for reasons in what they have done. The reasons constitute Pure Science. They have known the application of gunpowder for centuries; and yet the reasons for its peculiar action, if sought in the proper manner, would have developed the science of chemistry, and even of physics, with all their numerous applications. By contenting themselves with the fact that gunpowder will explode, and seeking no farther, they have fallen behind in the progress of the world; and we now regard this oldest and most numerous of nations as only barbarians. And yet our own country is in the same state. But we have done better; for we have taken the science of

the Old World and applied it to all our uses, accepting it like the rain of heaven, without asking whence it came, or even acknowledging the debt of gratitude we owe to the great and unselfish workers who have given it to us. And, like the rain of heaven, this Pure Science has fallen upon our country, and made it great and rich and strong.

To a civilised nation of the present day the applications of Science are a necessity; and our country has hitherto succeeded in this line, only for the reason that there are certain countries in the world where Pure Science has been and is cultivated, and where the study of Nature is considered a noble pursuit. But such countries are rare, and those who wish to pursue Pure Science in our own country must be prepared to face public opinion in a manner which requires much moral courage. They must be prepared to be looked down upon by every successful inventor whose shallow mind imagines that the only pursuit of mankind is wealth, and that he who obtains most has best succeeded in this world. Everybody can comprehend a million of money; but how few can comprehend any advance in scientific theory, especially in its more abstruse portions! And this, I believe, is one of the causes of the small number of persons who have ever devoted themselves to work of the higher order in any human pursuit. Man is a gregarious animal, and depends very much for his happiness on the sympathy of those around him; and it is rare to find one with the courage to pursue his own ideals in spite of his surroundings. In times past men were more isolated than at present, and each came in contact with a fewer number of people. Hence that time constitutes the period when the great sculptures, paintings, and poems were produced. Each man's mind was comparatively free to follow its own ideals, and the results were the great and unique works of the ancient masters. To-day the railroad and the telegraph, the books and the newspapers, have united each individual man with the rest of the world; instead of his mind being an individual, a thing apart by itself, and unique, it has become so influenced by the outer world, and so dependent upon it, that it has lost its originality to a great extent. The man who in times past would naturally have been in the lowest depths of poverty, mentally and physically, to-day measures tape behind a counter, and with lordly air advises the naturally born genius how he may best bring his outward appearance down to a level with his own. A new idea he never had, but he can at least cover his mental nakedness with ideas imbibed from others. So the genius of the past

soon perceives that his higher ideas are too high to be appreciated by the world; his mind is clipped down to the standard form; every natural offshoot upwards is repressed, until the man is no higher than his fellows. Hence the world, through the abundance of its intercourse, is reduced to a level. What was formerly a grand and magnificent landscape, with mountains ascending above the clouds, and depths whose gloom we cannot now appreciate, has become serene and peaceful. The depths have been filled, and the heights levelled, and the wavy harvests and smoky factories cover the landscape.

As far as the average man is concerned the change is for the better. The average life of man is far pleasanter, and his mental condition better, than before. But we miss the vigour imparted by the mountains. We are tired of mediocrity, the curse of our country. We are tired of seeing our artists reduced to hirelings, and imploring Congress to protect them against foreign competition. We are tired of seeing our countrymen take their science from abroad, and boast that they here convert it into wealth. We are tired of seeing our professors degrading their chairs by the pursuit of Applied Science instead of Pure Science, or sitting inactive while the whole world is open to investigation, lingering by the wayside while the problem of the universe remains unsolved. We wish for something higher and nobler in this country of mediocrity, for a mountain to relieve the landscape of its monotony. We are surrounded with mysteries, and have been created with minds to enjoy and reason to aid in the unfolding of such mysteries. Nature calls to us to study her, and our better feelings urge us in the same direction.

For generations there have been some few students of Science who have esteemed the study of Nature the most noble of pursuits. Some have been wealthy, and some poor; but they have all had one thing in common—the love of Nature and its laws. To these few men the world owes all the progress due to Applied Science, and yet very few ever received any payment in this world for their labours.

Faraday, the great discoverer of the principle on which all machines for electric lighting, electric railways, and the transmission of power must rest, died a poor man, although others and the whole world have been enriched by his discoveries. And such must be the fate of the followers in his footsteps for some time to come.

But there will be those in the future who will study Nature from pure love, and for them higher prizes than any yet

obtained are waiting. We have but yet commenced our pursuit of Science, and stand upon the threshold wondering what there is within. We explain the motion of the planet by the law of gravitation; but who will explain how two bodies, millions of miles apart, tend to go toward each other with a certain force?

We now weigh and measure electricity and electric currents with as much ease as ordinary matter, yet have we made any approach to an explanation of the phenomenon of electricity? Light is an undulatory motion, and yet do we know what it is that undulates? Heat is motion, yet do we know what it is that moves? Ordinary matter is a common substance, and yet who shall fathom the mystery of its internal constitution?

There is room for all in the work, and the race has but commenced. The problems are not to be solved in a moment, but need the best work of the best minds, for an indefinite time.

Shall our country be contented to stand by, while other countries lead in the race? Shall we always grovel in the dust, and pick up the crumbs which fall from the rich man's table counting ourselves richer than he because we have more crumbs, while we forget that he has the cake, which is the source of all crumbs? Shall we be swine, to whom the corn and husks are of more value than the pearls? If I read aright the signs of the times, I think we shall not always be contented with our inferior position. From looking down we have almost become blind, but may recover. In a new country the necessities of life must be attended to first. The curse of Adam is upon us all, and we must earn our bread.

But it is the mission of Applied Science to render this easier for the whole world. There is a story which I once read which will illustrate the true position of Applied Science in the world:—A boy, more fond of reading than of work, was employed, in the early days of the steam-engine, to turn the valve at every stroke. Necessity was the mother of invention in his case: his reading was disturbed by his work, and he soon discovered that he might become free from his work by so tying the valve to some movable portion of the engine as to make it move its own valve. So I consider that the true pursuit of mankind is intellectual. The scientific study of Nature in all its branches, of mathematics, of mankind in its past and present, the pursuit of art, and the cultivation of all that is great and noble in the world—these are the highest occupation of mankind. Commerce,

the applications of Science, the accumulation of wealth, are necessities which are a curse to those with high ideals, but a blessing to that portion of the world which has neither the ability nor the taste for higher pursuits.

As the applications of Science multiply, living becomes easier, the wealth necessary for the purchase of apparatus can better be obtained, and the pursuit of other things besides the necessities of life becomes possible.

But the moral qualities must also be cultivated in proportion to the wealth of the country, before much can be done in Pure Science. The successful sculptor or painter naturally attains to wealth through the legitimate work of his profession. The novelist, the poet, the musician, all have wealth before them as the end of a successful career. But the scientist and the mathematician have no such incentive to work: they must earn their living by other pursuits, usually teaching, and only devote their surplus time to the true pursuit of their science. And frequently, by the small salary which they receive, by the lack of instrumental and literary facilities, by the mental atmosphere in which they exist, and most of all, by their low ideals of life, they are led to devote their surplus time to Applied Science or to other means of increasing their fortune. How shall we, then, honour the few, the very few, who, in spite of all difficulties, have kept their eyes fixed on the goal, and have steadily worked for Pure Science, giving to the world a most precious donation, which has borne fruit in our greater knowledge of the universe and in the applications to our physical life which have enriched thousands and benefitted each one of us? There are also those who have every facility for the pursuit of Science, who have an ample salary and every appliance for works, yet who devote themselves to commercial work, to testifying in courts of law, and to any other work to increase their present large income. Such men would be respectable if they gave up the name of professor, and took that of consulting chemists or physicists. And such men are needed in the community. But for a man to occupy the professor's chair in a prominent college, and, by his energy and ability in the commercial applications of his science, stand before the local community in a prominent manner, and become the newspaper exponent of his science, is a disgrace both to him and his college. It is the death-blow to Science in that region. Call him by his proper name, and he becomes at once a useful member of the community. Put in his place a man who shall by precept and example cultivate his science, and how different

is the result! Young men looking forward into the world for something to do, see before them this high and noble life, and they see that there is something more honourable than the accumulation of wealth. They are thus led to devote their lives to similar pursuits, and they honour the professor who has drawn them to something higher than they might otherwise have aspired to reach.

I do not wish to be misunderstood in this matter. It is no disgrace to make money by an invention, or otherwise, or to do commercial scientific work under some circumstances. But let Pure Science be the aim of those in the chairs of professors, and so prominently the aim that there can be no mistake. If our aim in life is wealth, let us honestly engage in commercial pursuits, and compete with others for its possession. But if we choose a life which we consider higher, let us live up to it, taking wealth or poverty as it may chance to come to us, but letting neither turn us aside from our pursuit.

The work or teaching may absorb the energies of many; and, indeed, this is the excuse given by most for not doing any scientific work. But there is an old saying, that where there is a will there is a way. Few professors do as much teaching or lecturing as the German professors, who are also noted for their elaborate papers in the scientific journals. I myself have been burdened down with work, and know what it is; and yet I here assert that all *can* find time for scientific research if they desire it. But here, again, that curse of our country, mediocrity, is upon us. Our colleges and universities seldom call for first-class men of reputation, and I have even heard the trustee of a well-known college assert that no professor should engage in research because of the time wasted! I was glad to see, soon after, by the call of a prominent scientist to that college, that the majority of the trustees did not agree with him.

That teaching is important, goes without saying. A successful teacher is to be respected; but if he does not lead his scholars to that which is the highest, is he not blameworthy? We are, then, to look to the colleges and universities of the land for most of the work in Pure Science which is done. Let us therefore examine these latter, and see what the prospect is.

One, whom perhaps we may here style a practical follower of Ruskin, has stated that while in this country he was variously designated by the title of captain, colonel, and professor. The story may or may not be true, but we all know enough of the customs of our countrymen not to

dispute it on general principles. All men are born equal: some men are captains, colonels, and professors, and therefore all men are such. The logic is conclusive; and the same kind of logic seems to have been applied to our schools, colleges, and universities. I have before me the report of the commissioner of education for 1880. According to that report, there were 389,* or say, in round numbers, 400 institutions, calling themselves colleges or universities, in our country! We may well exclaim that ours is a great country, having more than the whole world beside. The fact is sufficient. The whole earth would hardly support such a number of first-class institutions. The curse of mediocrity must be upon them, to swarm in such numbers. They must be a cloud of mosquitoes, instead of eagles as they profess. And this becomes evident on further analysis. About one-third aspire to the name of university; and I note one called by that name which has two professors and 18 students, and another having three teachers and 12 students! And these instances are not unique, for the number of small institutions and schools which call themselves universities is very great. It is difficult to decide from the statistics alone the exact standing of these institutions. The extremes are easy to manage. Who can doubt that an institution with over 800 students, and a faculty of 70, is of a higher grade than those above cited having 10 or 20 students and two or three in the faculty? Yet this is not always true; for I note one institution with over 500 students which is known to me personally as of the grade of a high school. The statistics are more or less defective, and it would much weaken the force of my remarks if I went too much into detail. I append the following tables, however, of 330 so-called colleges and universities:—

218	had	from	0	to 100	students.
88	,,	,,	100	,, 200	,,
12	,,	,,	200	,, 300	,,
6	,,	,,	300	,, 500	,,
6	over		500		,,

Of 322 so-called colleges and universities:—

206	had	0	to 10	in the	faculty.
99	,,	10	,, 20	,,	,,
17	,,	20	or over	,,	,,

* 364 reported on, and 25 not reported.

If the statistics were forthcoming—and possibly they may exist—we might also get an idea of the standing of these institutions and their approach to the true university idea, by the average age of the scholars. Possibly also the ratio of number of scholars to teachers might be of some help. All these methods give an approximation to the present standing of the institutions. But there is another method of attacking the problem, which is very exact, but it only gives us the *possibilities* of which the institution is capable. I refer to the wealth of the institution. In estimating the wealth, I have not included the value of grounds and buildings, for this is of little importance, either to the present or future standing of the institution. As good work can be done in a hovel as in a palace. I have taken the productive funds of the institution as the basis of estimate. I find:—

234 have below 500,000 dols.
8 ,, between 500,000 and 1,000,000 dols.
8 ,, over 1,000,000.

There is no fact more firmly established, all over the world, than that the higher education can never be made to pay for itself. Usually the cost to a college, of educating a young man, very much exceeds what he pays for it, and is often three or four times as much. The higher the education, the greater this proportion will be; and a university of the highest class should anticipate only a small accession to its income from the fees of students. Hence the test I have applied must give a true representation of the possibilities in every case. According to the figures, only 16 colleges and universities have 500,000 dols. or over of invested funds, and only one-half of these have 1,000,000 dols. and over. Now, even the latter sum is a very small endowment for a college; and to call any institution a university which has less than 1,000,000 dols., is to render it absurd in the face of the world. And yet more than 100 of our institutions, many of them very respectable colleges, have abused the word "university" in this manner. It is to be hoped that the endowment of the more respectable of these institutions may be increased, as many of them deserve it; and their unfortunate appellation has probably been repented of long since.

But what shall we think of a community that gives the charter of a university to an institution with a total of 20,000 dols. endowment, two so-called professors, and 18 students? or another with three professors, 12 students,

and a total of 27,000 dols. endowment, mostly invested in buildings! And yet there are very many similar institutions; there being 16 with three professors or less, and very many indeed with only four or five.

Such facts as these could only exist in a democratic country, where pride is taken in reducing everything to a level. And I may also say that it can only exist in the early days of such a democracy; for an intelligent public will soon perceive that calling a thing by a wrong name does not change its character, and that truth, above all things, should be taught to the youth of the nation.

It may be urged that all these institutions are doing good work in education; and that many young men are thus taught, who could not afford to go to a true college or university. But I do not object to the education,—though I have no doubt an investigation would disclose equal absurdities here,—for it is aside from my object. But I do object to lowering the ideals of the youth of the country. Let them know that they are attending a school, and not a university; and let them know that above them comes the college, and above that the university. Let them be taught that they are only half educated, and that there are persons in the world by whose side they are but atoms. In other words, let them be taught the truth.

It may be that some small institutions are of high grade, especially those which are new; but who can doubt that more than two-thirds of our institutions calling themselves colleges and universities are unworthy of the name? Each one of these institutions has so-called professors, but it is evident that they can be only of the grade of teachers. Why should they not be so called? The position of teacher is an honoured one, but is not made more honourable by the assumption of a false title. Furthermore, the multiplication of the title, and the ease with which it can be obtained, render it scarcely worth striving for. When the man of energy, ability, and perhaps genius is rewarded by the same title and emoluments as the commonplace man with the modicum of knowledge, who takes to teaching, not because of any aptitude for his work, but possibly because he has not the energy to compete with his fellow-men in business, then I say one of the inducements for first-class men to become professors is gone.

When work and ability are required for the position, and when the professor is expected to keep up with the progress of his subject, and to do all in his power to advance it, and when he is selected for these reasons, then the position will

be worth working for, and the successful competitor will be honoured accordingly. The chivalric spirit which prompted Faraday to devote his life to the study of nature may actuate a few noble men to give their life to scientific work; but, if we wish to cultivate this highest class of men in science, we must open a career for them worthy of their efforts.

Jenny Lind, with her beautiful voice, would have cultivated it to some extent in her native village; yet who would expect her to travel over the world, and give concerts for nothing? and how would she have been able to do so if she had wished? And so the scientific man, whatever his natural talents, must have instruments and a library, and a suitable and respectable salary to live upon, before he is able to exert himself to his full capacity. This is true of advance in all the higher departments of human learning, and yet something more is necessary. It is not those in this country who receive the largest salary, and have positions in the richest colleges, who have advanced their subject the most: men receiving the highest salaries, and occupying the professor's chair, are to-day doing absolutely nothing in Pure Science, but are striving by the commercial applications of their science to increase their already large salary. Such pursuits, as I have said before, are honourable in their proper place; but the duty of a professor is to advance his science, and to set an example of pure and true devotion to it which shall demonstrate to his students and the world that there is something high and noble worth living for. Money-changers are often respectable men, and yet they were once severely rebuked for carrying on their trade in the court of the Temple.

Wealth does not constitute a university, buildings do not: it is the men who constitute its faculty, and the students who learn from them. It is the last and highest step which the mere student takes. He goes forth into the world, and the height to which he rises has been influenced by the ideals which he has consciously or unconsciously imbibed in his university. If the professors under whom he has studied have been high in their profession, and have themselves had high ideals; if they have considered the advance of their particular subject their highest work in life, and are themselves honoured for their intellect throughout the world, —the student is drawn toward that which is highest, and ever after in life has high ideals. But if the student is taught by what are sometimes called good teachers, and teachers only, who know little more than the student, and who are often surpassed and even despised by him, no one can

doubt the lowered tone of his mind. He finds that by his feeble efforts he can surpass one to whom a university has given its highest honour; and he begins to think that he himself is a born genius, and the incentive to work is gone. He is great by the side of the molehill, and does not know any mountain to compare himself with.

A university should not only have great men in its faculty, but have numerous minor professors and assistants of all kinds, and should encourage the highest work, if for no other reason than to encourage the student to his highest efforts.

But, assuming that the professor has high ideals, wealth such as only a large and high university can command is necessary to allow him the fullest development.

And this is specially so in our science of physics. In the early days of physics and chemistry, many of the fundamental experiments could be performed with the simplest apparatus. And so we often find the names of Wollaston and Faraday mentioned as needing scarcely anything for their researches. Much can even now be done with the simplest apparatus; and nobody, except the utterly incompetent, need stop for want of it. But the fact remains, that one can only be free to investigate in all departments of chemistry and physics, when he not only has a complete laboratory at his command, but a friend to draw on for the expenses of each experiment. That simplest of the departments of physics, namely, astronomy, has now reached such perfection that nobody can expect to do much more in it without a perfectly equipped observatory; and even this would be useless without an income sufficient to employ a corps of assistants to make the observations and computations. But even in this simplest of physical subjects, there is great misunderstanding. Our country has very many excellent observatories: and yet little work is done in comparison, because no provision has been made for maintaining the work of the observatory; and the wealth which, if concentrated, might have made one effective observatory which would prove a benefit to astronomical science, when scattered among a half-dozen, merely furnishes telescopes for the people in the surrounding region to view the moon with. And here I strike the keynote of at least one need of our country, if she would stand well in Science; and the following item, which I clip from a newspaper, will illustrate the matter:—

"The eccentric old Canadian, Arunah Huntington, who left 200,000 dols. to be divided among the public scools of Vermont, has done something which will be of little practical

value to the schools. Each district will be entitled to the insignificant sum of 10 dols., which will not advance much the cause of education."

Nobody will dispute the folly of such a bequest, or the folly of filling the country with telescopes to look at the moon, and calling them observatories. How much better to concentrate the wealth into a few parcels, and make first-class observatories and institutions with it!

Is it possible that any of our four hundred colleges and universities have love enough of learning to unite with each other and form larger institutions? Is it possible that any have such a love of truth that they are willing to be called by their right name? I fear not; for the spirit of expectation, which is analogous to the spirit of gambling, is strong in the American breast, and each institution which now, except in name, slumbers in obscurity, expects in time to bloom out into full prosperity. Although many of them are under religious influence, where truth is inculcated, and where men are taught to take a low seat at the table in order that they may be honoured by being called up higher, and not dishonoured by being thrust down lower, yet these institutions have thrust themselves into the highest seats, and cannot probably be dislodged.

But would it not be possible to so change public opinion that no college could be founded with a less endowment than say 1,000,000, or no university with less than three or four times that amount? From the report of the Commissioner of Education, I learn that such a change is taking place; that the tendency towards large institutions is increasing, and that it is principally in the west and south-west that the multiplication of small institutions with big names is to be feared most, and that the east is almost ready for the great coming university.

The total wealth of the four hundred colleges and universities in 1880 was about 40,000,000 dols. in buildings, and 43,000,000 dols. in productive funds. This would be sufficient for one great university of 10,000,000 dols., four of 5,000,000 dols., and twenty-six colleges of 2,000,000 dols. each. But such an idea can of course never be carried out. Government appropriations are out of the question, because no political trickery must be allowed around the ideal institution.

In the year 1880 the private bequests to all schools and colleges amounted to about 5,500,000 dols.; and, although there was one bequest of 1,250,000 dols., yet the amount does not appear to be phenomenal. It would thus seem that the

total amount was about 5,000,000 dols. in one year, of which more than half is given to so-called colleges and universities. It would be very difficult to regulate these bequests so that they might be concentrated sufficiently to produce an immediate result. But the figures show that generosity is a prominent feature of the American people, and that the needs of the country only have to be appreciated to have the funds forthcoming. We must make the need of research and of Pure Science felt in the country. We must live such lives of pure devotion to our Science, that all shall see that we ask for money, not that we may live in indolent ease at the expense of charity, but that we may work for that which has advanced and will advance the world more than any other subject, both intellectually and physically. We must live such lives as to neutralise the influence of those who in high places have degraded their profession, or have given themselves over to ease, and do nothing for the science which they represent. Let us do what we can with the present means at our disposal. There is not one of us who is situated in the position best adapted to bring out all his powers, and to allow him to do most for his science. All have their difficulties, and I do not think that circumstances will ever radically change a man. If a man has the instinct of research in him, it will always show itself in some form. But circumstances may direct it into new paths, or may foster it so that what would otherwise have died as a bud now blossoms and ripens into the perfect fruit.

Americans have shown no lack of invention in small things; and the same spirit, when united to knowledge and love of Science, becomes the spirit of research. The telegraph operator, with his limited knowledge of electricity and its laws, naturally turns his attention to the improvement of the only electrical instrument he knows anything about; and his researches would be confined to the limited sphere of his knowledge, and to the simple laws with which he is acquainted. But as his knowledge increases, and the field broadens before him, as he studies the mathematical theory of the subject, and the electro-magnetic theory of light loses the dim haze due to distance, and becomes his constant companion, the telegraph instrument becomes to him a toy, and his effort to discover something new becomes research in Pure Science.

It is useless to attempt to advance Science until one has mastered the science; he must step to the front before his blows can tell in the strife. Furthermore, I do not believe anybody can be thorough in any department of Science,

without wishing to advance it. In the study of what is known, in the reading of the scientific journals, and the discussions therein contained of the current scientific questions, one would obtain an impulse to work, even though it did not before exist. And the same spirit which prompted him to seek what was already known, would make him wish to know the unknown. And I may say that I never met a case of thorough knowledge in my own science, except in the case of well-known investigators. I have met men who talked well, and I have sometimes asked myself why they did not do something; but further knowledge of their character has shown me the superficialty of their knowledge. I am no longer a believer in men who could do something if they would, or would do something if they had a chance. They are impostors. If the true spirit is there, it will show itself in spite of circumstances.

As I remarked before, the investigator in Pure Science is usually a professor. He must teach as well as investigate. It is a question which has been discussed in late years, as to whether these two functions would better be combined in the same individual, or separated. It seems to be the opinion of most, that a certain amount of teaching is conducive, rather than otherwise, to the spirit of research. I myself think that this is true, and I should myself not like to give up my daily lecture. But one must not be overburdened. I suppose that the true solution, in many cases, would be found in the multiplication of assistants, not only for the work of teaching, but of research. Some men are gifted with more ideas than they can work out with their own hands, and the world is losing much by not supplying them with extra hands. Life is short; old age comes quickly, and the amount one pair of hands can do is very limited. What sort of shop would that be, or what sort of factory, where one man had to do all the work with his own hands? It is a fact in nature, which no democracy can change, that men are *not* equal—that some have brains, and some hands. And no idle talk about equality can ever subvert the order of the universe.

I know of no institution in this country where assistants are supplied to aid directly in research. Yet why should it not be so? And even the absence of assistant professors and assistants of all kinds, to aid in teaching, is very noticeable, and must be remedied before we can expect much.

There are many physical problems, especially those requiring exact measurements, which cannot be carried out by one man, and can only be successfully attacked by the most

elaborate apparatus, and with a full corps of assistants. Such are Regnault's experiments on the fundamental laws of gases and vapours, made thirty or forty years ago by aid from the French Government, and which are the standards to this day. Although these experiments were made with a view to the practical calculation of the steam-engine, yet they were carried out in such a broad spirit that they have been of the greatest theoretical use. Again, what would astronomy have done without the endowments of observatories? By their means, that science has become the most perfect of all branches of physics, as it should be from its simplicity. There is no doubt, in my mind, that similar institutions for other branches of physics, or, better, to include the whole of physics, would be equally successful. A large and perfectly equipped physical laboratory with its large revenues, its corps of professors and assistants, and its machine shop for the construction of new apparatus, would be able to advance our science quite as much as endowed observatories have astronomy. But such a laboratory should not be founded rashly. The value will depend entirely on the physicist at its head, who has to devise the plan, and to start it into practical working. Such a man will always be rare, and cannot always be obtained. After one had been successfully started, others could follow; for imitation requires little brains.

One could not be certain of getting the proper man every time, but the means of appointment should be most carefully studied so as to secure a good average. There can be no doubt that the appointment should rest with a scientific body capable of judging the highest work of each candidate.

Should any popular element enter, the person chosen would be either of the literary-scientific order, or the dabbler on the outskirts who presents his small discoveries in the most theatrical manner. What is required is a man of depth, who has such an insight into physical science that he can tell when blows will best tell for its advancement.

Such a grand laboratory as I describe does not exist in the world, at present, for the study of physics. But no trouble has ever been found in obtaining means to endow astronomical science. Everybody can appreciate, to some extent, the value of an observatory; as astronomy is the simplest of scientific subjects, and has very quickly reached a position where elaborate instruments and costly computations are necessary to further advance. The whole domain of physics is so wide that workers have hitherto found enough to do. But it cannot always be so, and the time

has even now arrived when such a grand laboratory should be founded. Shall our country take the lead in this matter, or shall we wait for foreign countries to go before? They will be built in the future, but when and how is the question.

Several institutions are now putting up laboratories for physics. They are mostly for teaching, and we can expect only a comparatively small amount of work from most of them. But they show progress; and, if the progress be as quick in this direction as in others, we should be able to see a great change before the end of our lives.

As stated before, men are influenced by the sympathy of those with whom they come in contact. It is impossible to immediately change public opinion in our favour; and, indeed, we must always seek to lead it, and not be guided by it. For Pure Science is the pioneer who must not hover about cities and civilised countries, but must strike into unknown forests, and climb the hitherto inaccessible mountains which lead to and command a view of the promised land,—the land which Science promises us in the future; which shall not only flow with milk and honey, but shall give us a better and more glorious idea of this wonderful universe. We must create a public opinion in our favour, but it need not at first be the general public. We must be contented to stand aside, and see the honours of the world for a time given to our inferiors; and must be better contented with the approval of our own consciences, and of the very few who are capable of judging our work, than of the whole world beside. Let us look to the other physicists, not in our own town, not in our own country, but in the whole world, for the words of praise which are to encourage us, or the words of blame which are to stimulate us to renewed effort. For what to us is the praise of the ignorant? Let us join together in the bonds of our scientific societies, and encourage each other, as we are now doing, in the pursuit of our favourite study; knowing that the world will some time recognise our services, and knowing, also, that we constitute the most important element in human progress.

But danger is also near, even in our societies. When the average tone of the societies is low, when the highest honours are given to the mediocre, when third-class men are held up as examples, and when trifling inventions are magnified into scientific discoveries, then the influence of such societies is prejudicial. A young scientist attending the meetings of such a society soon gets perverted ideas. To his mind a molehill is a mountain, and the mountain a molehill. The small inventor or the local celebrity rises to

a greater height, in his mind, than the great leader of Science in some foreign land. He gauges himself by the molehill, and is satisfied with his stature, not knowing that he is but an atom in comparison with the mountain, until, perhaps, in old age, when it is too late. But if the size of the mountain had been seen at first, the young scientist would at least have been stimulated in his endeavour to grow.

We cannot all be men of genius; but we can, at least, point them out to those around us. We may not be able to benefit Science much ourselves; but we can have high ideals on the subject, and instil them into those with whom we come in contact. For the good of ourselves, for the good of our country, for the good to the world, it is incumbent on us to form a true estimate of the worth and standing of persons and things, and to set before our own minds all that is great and good and noble, all that is most important for scientific advance, above the mean and low and unimportant.

It is very often said that a man has a right to his opinion. This might be true for a man on a desert island, whose error would influence only himself. But when he opens his lips to instruct others, or even when he signifies his opinions by his daily life, then he is directly responsible for all his errors of judgment or fact. He has no right to think a molehill as big as a mountain, nor to teach it, any more than he has to think the world flat, and teach that it is so. The facts and laws of our science have *not* equal importance, neither have the men who cultivate the science achieved equal results. One thing is greater than another, and we have no right to neglect the order. Thus shall our minds be guided aright, and our efforts be toward that which is the highest.

Then shall we see that no physicist of the first class has ever existed in this country, that we must look to other countries for our leaders in that subject, and that the few excellent workers in our country must receive many accessions from without before they can constitute an American science, or do their share in the world's work.

But let me return to the subject of scientific societies. Here American science has its hardest problem to contend with. There are very many local societies dignified by high-sounding names, each having its local celebrity, to whom the privilege of describing some crab with an extra claw, which he found in his morning ramble, is inestimable. And there are some academies of science, situated at our seats of learning, which are doing good work in their locality. But distances are so great that it is difficult to collect men

together at any one point. The American Association, which we are now attending, is not a scientific academy, and does not profess to be more than a gathering of all who are interested in Science, to read papers and enjoy social intercourse. The National Academy of Sciences contains eminent men from the whole country, but then it is only for the purpose of advising the Government freely on scientific matters. It has no building, it has no library, and it publishes nothing except the information which it freely gives to the Government, which does nothing for it in return. It has not had much effect directly on American science; but the liberality of the Government in the way of scientific expeditions, publications, &c., is at least partly due to its influence, and in this way it has done much good. But it in no way takes the place of the great Royal Society, or the great Academies of Science at Paris, Berlin, Vienna, St. Petersburg, Munich, and indeed all the European capitals and large cities. These, by their publications, give to the young student, as well as the more advanced physicist, models of all that is considered excellent; and to become a member is one of the highest honours to which he can aspire, while to write a memoir which the Academy considers worthy to be published in its Transactions excites each one to his highest effort.

The American Academy of Sciences in Boston is perhaps our nearest representation of this class of academies, but its limitation of membership to the State deprives it of its national character.

But there is another matter which influences the growth of our science.

As it is necessary for us still to look abroad for our highest inspiration in Pure Science, and as Science is not an affair of one town or of one country, but of the whole world, it becomes us all to read the current Journals of Science and the great Transactions of foreign societies, as well as those of our own countries. These great Transactions and Journals should be in the library of every Institution of learning in the country where Science is taught. How can teachers and professors be expected to know what has been discovered in the past, or is being discovered now, if these are not provided? Has any Institution a right to mentally starve the teachers whom it employs, or the students who come to it? There can be but one answer to this; and an Institution calling itself a University, and not having the current scientific Journals upon its table, or the Transactions of Societies upon its library-shelves, is certainly not doing its best to cultivate all that is best in this world.

We call this a free country, and yet it is the only one where there is a direct tax upon the pursuit of Science. The low state of Pure Science in our country may possibly be attributed to the youth of the country; but a direct tax, to prevent the growth of our country in that subject, cannot be looked upon as other than a deep disgrace. I refer to the duty upon foreign books and periodicals. In our science no books above elementary ones have ever been published, or are likely to be published, in this country; and yet every teacher in physics must have them, not only in the college library, but on his own shelves, and must pay the Government of this country to allow him to use a portion of his small salary to buy that which is to do good to the whole country. All freedom of intercourse which is necessary to foster our growing science is thus broken off, and that which might in time relieve our country of its mediocrity is nipped in the bud by our Government, which is most liberal when appealed to directly on scientific subjects.

One would think that books in foreign languages might be admitted free; but to please the half-dozen or so workmen who reprint German books, not scientific, our free intercourse with that country is cut off. Our scientific associations and societies must make themselves heard in this matter, and show those in authority how the matter stands.

In conclusion, let me say once more that I do not believe that our country is to remain long in its present position. The science of physics, in whose applications our country glories, is to arise among us, and make us respected by the nations of the world. Such a prophecy may seem rash with regard to a nation which does not yet do enough physical work to support a physical journal. But we know the speed with which we advance in this country: we see cities springing up in a night, and other wonders performed at an unprecedented rate. And now we see physical laboratories being built; we see a great demand for thoroughly trained physicists, who have not shirked their mathematics, both as professors and in so-called practical life; and perhaps we have the feeling common to all true Americans, that our country is going forward to a glorious future, when we shall lead the world in the strife for intellectual prizes as we now do in the strife for wealth.

But if this is to be so, we must now aim low. The problems of the universe cannot be solved without labour; they cannot be attacked without the proper intellectual as well as physical tools, and no physicist need expect to go far without his mathematics. No one expects a horse to win in a

great and long race who has not been properly trained; and it would be folly to attempt to win with one, however pure his blood and high his pedigree, without it. The problems we solve are more difficult than any race: the highest intellect cannot hope to succeed without proper preparation. The great prizes are reserved for the greatest efforts of the greatest intellects, who have kept their mental eye bright and flesh hard by constant exercise. Apparatus can be bought with money, talents may come to us at birth; but our mental tools, our mathematics, our experimental ability, our knowledge of what others have done before us, all have to be obtained by work. The time is almost past, even in our own country, when third-rate men can find a place as teachers, because they are unfit for everything else. We wish to see brains and learning, combined with energy and immense working-power, in the professor's chair; but, above all, we wish to see that high and chivalrous spirit which causes one to pursue his idea in spite of all difficulties,—to work at the problems of Nature with the approval of his own conscience, and not of men before him. Let him fit himself for the struggle with all the weapons which mathematics and the experience of those gone before him can furnish, and let him enter the arena with the fixed and stern purpose to conquer. Let him not be contented to stand back with the crowd of mediocrity, but let him press forward for a front place in the strife.

The whole universe is before us to study. The greatest labour of the greatest minds has only given us a few pearls; and yet the limitless ocean, with its hidden depths filled with diamonds and precious stones, is before us. The problem of the universe is yet unsolved, and the mystery involved in one single atom yet eludes us. The field of research only opens wider and wider as we advance, and our minds are lost in wonder and astonishment at the grandeur and beauty unfolded before us. Shall we help in this grand work, or not? Shall our country do its share, or shall it still live in the almshouse of the world?

ANALYSES OF BOOKS.

Harmonies of Tones and Colours developed by Evolution. By F. J. HUGHES. London: Marcus Ward and Co.

MOST of our readers must be aware that to certain persons there is a distinct connection between tone and colour. To them, as we are told, the hearing of a tone suggests or calls up the impression of a colour, and the sight of a colour in an analogous manner conveys the sensation of a tone. All this, indeed, is something which lies entirely outside the bounds of our personal experience. Still we feel no right to deny such statements, lest we might fall into the error, *e.g.*, of a colour-blind person who should doubt the diversity of shades in the spectrum. The author of the work before us—who, by the way, is a second cousin of Charles Darwin—does not lay claim to the possession of this natural perception of the connection between tones and colours, but by studying the harmonies of both he has reached certain most interesting conclusions. We must, however, admit at the outset that the subject is involved in difficulties. Concerning colour—a matter which we have approached from the double point of view of the student of organic nature, and that of the tinctorial chemist—we may at any rate claim a little knowledge. But of acoustics, and still more decidedly of harmony, we know absolutely nothing, and to us, therefore, this work is as if in great part written in some unknown tongue.

The author maintains that "the fountain or life of musical harmonies and colours is E, or yellow; the root B, or ultra-violet; these being, in fact, tints and shades of white and black. Ascending they partake more of white; descending, of black; the former drawing tones and colours higher, the latter lower. Throughout the scheme seven tones and seven colours develop in every harmony. In the relationship between tones and colours the seven may be condensed into a pair: as an example we trace the notes and colours in the fundamental scale of C. C rises from the fountain, and contains all tones within itself. *Red* also rises from the fountain, and contains all colours, with white and black. D = the notes C and E mingled; *Orange*, red and yellow mingled. E, the root of the fountain. *Yellow*, containing all colours, is white in its extreme. F = the notes E and G mingled. *Green* = yellow and blue mingled. G contains all tones. *Blue*, with more or less of black and white. A = G and B mingled. *Violet* = blue and all colours inclining to black. B, the key-note of the fountain. *Ultra-violet* = violet mingled with

more black, a deeper shade of all colours—in its extreme black."

In this parallelism of notes and colours we do not find the clearness which would be desirable. Red, yellow, and blue, if we understand Mr. Hughes aright, contain each all colours. We should like to see some experimental proof of this proposition. As far as research has gone, true red—the red of the spectrum—is what might be called a chromatic element from which nothing but red can be eliminated, although it may be blended with other colours to form compound shades. As regards yellow and blue, which the author classes along with red as "the three great apparent primaries," their elementary or simple character is not generally recognised. Indeed Mr. Hughes refers to Clerk Maxwell's proof that red and green in right proportions produce yellow. Violet the author likens to "blue and all colours inclining to black." To our eye a true violet might rather seem blue inclining to red. On the other hand, blue colours are now actually produced in the arts by mixtures of green and violet, a result which has only become possible since colours of a very high degree of purity have been obtainable.

Again, we do not distinctly see the meaning to be conveyed by the words "yellow, containing all colours is white in its extreme;" and again, "although yellow, as a colour, is explained away as white, it is nevertheless the colour yellow in endless tints and shades throughout Nature." Frankly speaking we do not know what the "extreme" of yellow is. If we seek such an "extreme" we pass into green on the one hand, and into orange on the other. If we take a yellow solution—*e.g.*, that of potassium dichromate—and dilute it with more and more distilled water, we get at last a colourless liquid. But we get the very same result by similarly diluting a solution of methyl-green or of eosine. When the author, however, puts yellow = E as the root of the fountain he seems to us to convey a truth which has been arrived at by other enquirers in a totally different manner. Yellow appears, in the evolution of plants and animals, to be the lowest stage of colouration, which Nature produces most readily, and at which she often stops short.

Those of our readers who wish to pursue this interesting and most difficult subject will do well to re-read an article on "Light and Sound," by Prof. W. F. Barrett, which appeared in the "Quarterly Journal of Science" for January, 1870, and which Mr. Hughes here quotes. This eminent physicist also assumes the note C to correspond to the colour red, finds D correspond to orange, E to yellow, and F to green.

Mr. Hughes says:—"The twelve notes, scales, and chords in the major and minor series, &c., all agree so exactly in their mode of development that if a piece of music is written correctly in colours, with their intermediate tints and shades, the experienced musician can, as a rule, detect errors more quickly

and surely with the eye than with the ear." We much regret that we are unable to understand the diagrams—music printed partly in colours—in which the author seeks to demonstrate his views.

The Natural Genesis: or, Second Part of a Book of the Beginnings, containing an Attempt to Recover and Re-constitute the Lost Origins of the Myths and Mysteries, Types and Symbols, Religion and Language, with Egypt for the Mouthpiece and Africa as the Birthplace. By GERALD MASSEY. Vol. II. London: Williams and Norgate.

IN our issue for July of the present year we had the pleasure of giving a notice of the first volume of this extraordinary work. We could do no other than recognise its importance as the first systematic attempt to throw the light of Evolution into regions where it has been hitherto ignored, if not systematically rejected. At the same time we cannot help feeling that Mr. Massey runs some danger, to use an old proverb, of falling to the ground between two stools. On the one hand, the men who best understand and value Evolution, such as embryologists, taxonomists, and palæontologists, will be apt to turn away from the contemplation of myths and mysteries as something totally outside the sphere of their researches and studies. On the other hand, the mythologists, the students of primæval history, religions, and languages, regarding for the most part man as a being who has not risen from an original bestial condition, will be apt to give the author's views only a very scanty and superficial examination. We would venture a word of remonstrance with both parties. The naturalist claims, and must claim, anthropology as a part of his legitimate subject, and should therefore not overlook a work which so distinctly asserts and establishes this his claim. Again, the archæologist, the historian, and the philologist, if their object be really the discovery of truth, should not shrink back in horror at finding the facts of their respective sciences or eruditions set before them from a novel point of view.

The present volume treats, in successive chapters, of the natural genesis and typology of the mythical creations, the natural genesis and typology of the fall in heaven and on earth, of the deluge and the ark, of the natural genesis of time and the typology of the word or *logos*, and the typology of equinoctial christolatry.

We must at once admit that there is in this volume, even more than in the former one, much which cannot be legitimately discussed in the "Journal of Science," and much, also, which we are not qualified to deal with anywhere. To certain passages,

especially in the earlier chapters, we may here, however, direct attention. Concerning the commonly accepted meaning of the word Paradise the author says:—"This comes of looking for the old lost Paradise in the shape of a Hebrew garden. *Pardez*, the Armenian paradise, the Persian *pardis*, the modern Arabic *firdaus*, applied to park or garden, is too late an application for an interpretation of the beginnings. Human gardens were not inclosed or cultivated when the Paratesh was formed."

Speaking of the *Airyana-vaejo* of the Avesta, Mr. Massey writes:—"This was at one time considered by the 'best authorities' to have been the starting-point of successive and most ancient migrations of the much overlauded Aryan race. But mythology and its naming preceded geography."

Concerning the origin of mankind the author says—"The creation of man or of men in the primordial mythes has no relation whatever to human beings, but to the earliest representations of celestial phenomena. It is so common a mode of expression that anthropologists even speak of the 'first man' as if he were a reality. We are frequently informed that such an one was the 'Adam,' the 'first man' of this or the other people, as if that explained anything. There is no more a first man in mythology, as a human being, than there is a primal individual parent known to Evolution. There never was a first man. That is, there never was a time when there was not a whole species of the animal at whatsoever stage of development, and the earliest myth-makers did not pretend to know anything about a first man, as a human being."

In summing up the most important teachings of this chapter Mr. Massey says—"Speaking generally the creations are stellar, lunar, and solar; the series corresponds to that of the heavenly bodies which in the Avesta, for instance, is invariably given in the order of stars, moon, and sun, where we should say sun, moon, and stars. That which was latest with the earlier men becomes first with the later, and thus we have been *grounded in non-evolution* as a mode of education; consequently much of our current explanation of the backward past in history, religion, mythology, and theology, is akin to that which accounted for the fossils found on mountain-tops, by supposing that pilgrims in passing from land to land had dropped their cockle-shells."

We regret that lack of space forbids us to give the author's appreciation of Buddhism, which in these days of "Occultism" will not be received with unmixed approval.

We cannot conclude this brief notice without bespeaking for the "Natural Genesis" the careful attention of anthropologists. Like ourselves they will probably feel unable to accept all the author's conclusions, but, again like ourselves, they will feel that he has at least been working in the right direction.

Accented Five-figure Logarithms of Numbers from 1 *to* 99999, *without Differences.* Arranged and accented by LEWIS D'A. JACKSON. London: W. H. Allen and Co.

THE author, in his Introduction, advocates the use for ordinary purposes of four- or five-figure logarithms in place of the seven-figured. He remarks that the computers in the Nautical Almanack office can calculate the whole of their occultations, almost all their eclipses, and all the places of the stars except the circumpolar ones, with four-figure trigonometrical logarithms, giving minutes of arc. Wherever the entire seven figures cannot be utilised, their employment is a waste of time and labour. By his system of accentuation he offers a remedy for the defects of five-figure logarithms, as he has done in a previous work for those of four figures. The author denotes, *e.g.*, log. 88637 by $94762_{\cdot}$, log. 88638 by 94762. and log. 88639 by $94762_{\cdot}$; the two signs, the dash above and the dot below, have the same mean value, one being 0·3 less and the other 0·3 more than the first plain number. Instructions, with examples, are then given for computing with accented logarithms.

In addition to the table referred to in the title-page, there is a table of accented five-figure logarithms for sines, tangents, cotangents, and cosines of angles from 0° to 90°, to every hundredth of a degree.

The work finishes with a comparative table of French and English decimal scientific systems. Many of our readers will not require to be told that Mr. Jackson has re-cast the decimal system of weights and measures in a manner which, while retaining its advantages, does away with the objections urged against it by practical men. In particular, he has introduced or retained plain short names for the different denominations in place of the awkward and lengthy terminology which the French unhappily introduced.

Longman's Magazine. No. XII. October, 1883. London: Longmans and Co.

WE find here a very remarkable paper, by Dr. B. W. Richardson, entitled "Cycling as an Intellectual Pursuit." In this light we suspect it will have been very rarely regarded, the more as a large part of its votaries do not seem overburdened with intelligence. The writer begins with a confession which we hope is not true of the majority of men, even when well advanced in years. He says:—"If I walk ten miles in three hours—a fair pace—I am tired: my ankles feel weak, my feet sore, my

muscles weary; so that after the effort I am unfitted for any mental work until recruited by a long rest." Such inconveniences after travelling the same distance on a tricycle Dr. Richardson does not feel, but, on the contrary, is "agreeably refreshed and ready for study or other mental occupation."

After this comparison, unfavourable to man's natural locomotive organs, he goes on to show the physical advantages of "cycling," to defend it against objectors, and to record the performances of various persons with the two- or the three-wheeled machine. At last we come to the pith of the matter. The suggestion the author has to offer is "that the ladies and gentlemen who at this time are making cycling a pastime should form themselves into an association for collecting various kinds of information while they are carrying on their excursions in this and in other countries." He suggests the organisation of such a Society, and its division into four sections,—an archæological, a geographical, a natural-historical, and a mechanical. The members of the Society are to collect information under these heads, to hand it for collation to local offices, whence it is to be transmitted to the head-quarters of the Society.

We will now endeavour to form an estimate of the feasibility of this startling proposal. It strikes us that the cyclist moves too fast for anything like a close observation of Nature, whilst, however skilful and experienced he may be, some portion of his attention will be drawn off to the management of his machine. Again, he is almost exclusively confined to the main roads: the woodland paths, the mountain declivities, the precipitous river-banks, the marshes, and peat-moors, where respectively the botanist, the entomologist, the mineralogist, &c., find their best harvests, must be for him forbidden ground. Or if he leaves his "cycle" on the road, and goes on foot into the thickets and among the rocks to make the explorations, he will be continually under the necessity of coming back to his mechanical roadster. Hence he will find himself at a heavy disadvantage as compared with the pedestrian.

But possibly Dr. Richardson may mean that the cyclist is merely to travel down by machine to some central spot, take up his quarters there, and explore the neighbourhood on foot. This, of course, will be perfectly feasible, and the tourist will then be in no worse and no better a position than if he had come from home by train or by ship.

It must also be remembered that—at least as far as Natural History and Archæology are concerned—that minute exploration which Dr. Richardson thinks his associated cyclists might effect, is being already done by local societies. These bodies are now numerous, earnest, and disposed to co-operate with each other. They are making minute examinations of the floræ and the faunæ of their respective districts, and noting down the geological features. In France, and still more in Germany, the same work

is being carried on. Almost every town of any standing has its *Naturforschende Gesellschaft*, whilst every University, every Real-Schule, and nearly every Gymnasium sends out its bands of explorers during vacation. We are far from saying that everything, even in Central Europe, is fully explored; but in the most promising districts a cycle of any kind would be found decidedly *de trop*.

Nor can we forget that the cyclicts as a body are not trained observers, and would, perhaps, not readily become such. The habit of skimming along level roads at a rapid rate, thinking of little but how many miles can be got over in the day, is a poor preparation for seeing everything and into everything.

Altogether we are inclined to think Dr. Richardson's suggestion as lacking in the practical element.

"Toads, Past and Present," by Mr. E. Kay Robinson, is a curious summary of the traditional notions concerning toads. He writes:—"For many years the semi-scientific public had learned to regard the toad as a perfectly harmless reptile. Real Science, however, in the guise of the 'Lancet,' has come more or less to Shakespeare's rescue; for that journal last year discovered, *more suo*, that the venom [secretion of the cutaneous glands] of a toad injected beneath the skin of a dog produces convulsions." Now that the toad, like certain other Batrachians, has a poisonous secretion was known a good many years before this alleged discovery. Still, as the reptile has no means of introducing this venom into the bodies of other animals, it is practically harmless, and the semi-scientific public is in the right. We can, from our own superabundant experience, deny that there is any danger in handling toads.

The Popular Science Monthly. October, 1883.

We find in this issue much matter deserving a careful consideration. Foremost stands a reply by Paul R. Shipman to the paper recently read by Dr. Lionel Beale before the Victoria Institute, and republished by that body in the form of a pamphlet. Dr. Beale, we are told, admits by implication that known causes have not yet been proved inadequate to explain the phenomena of life. His cautious statement is that they are inadequate "*in the present state of scientific knowledge.*" Hence his assumption of a special power to account for the phenomena peculiar to living beings is declared a violation of the principle known ir older philosophical literature as "Occam's razor," but now more generally known as the "law of parsimony." This law forbids the assumption of an unknown cause before the inadequacy of

known causes has been demonstrated. Those who carefully read this paper will scarcely find their respect for Dr. Beale as a thinker undiminished.

Dr. E. Bayard communicates a paper bearing the unhappy title "Homœopathy as a Science." One of the first signs of the approaching millennium will be a cessation of this misuse of the term Science. It has been again and again enforced by men of the highest ability that Science merely perceives and declares what exists. To do anything, or to instruct man how or what to do, belongs in the province not of Science, but of Art. Homœopathy, whether it be the correct method of treating disease or no,—a question into which we cannot enter,—is no more a Science than allopathy, or than metallurgy, or pyrotechnics, all *arts* aiming at certain ends.

Dr. F. Oswald gives one of his clever, but one-sided, papers on the "Remedies of Nature." He denounces tea and coffee as evils of the same class as tobacco, opium, and alcohol, to which they lead the way. As usual he advocates vegetarianism. He speaks of Bichat proving "that our digestive organs are those of a frugivorous [phytophagous] animal." We would defy any Bichat to prove that our digestive organs are less adapted for a mixed diet than are those of the majority of the Rodents (Muridæ, Sciuridæ, &c.), of the Suidæ, or of the monkeys, which are well known to consume eggs and insects—animal matter as truly as beef or mutton. Dr. Oswald tells us that the first taste of every poison is either insipid or repulsive. Is this the case with certain poisonous fishes and fungi, and with some kinds of poisonous honey? "The only safe, consistent, and effective plan is Total Abstinence from all Poisons." But if we are entirely to abstain from all substances which would prove fatal or injurious if taken in large doses or in a concentrated form, our diet will be strangely limited. The ordinary garden fruits and vegetables contain such acids as the tartaric, malic, citric, &c. Are they therefore to be rejected? Nevertheless there is too much truth in the paper before us.

"The Historical Development of Modern Nursing," by Dr. A. Jacobi, corrects a widespread error. It is commonly supposed that hospitals are an outcome of Christianity; but the author shows that they existed in Ceylon, under Buddhist auspices, in the second, and even in the fifth, century before the Christian era. May not their absence in the days of classical antiquity be in part due to a smaller prevalence of chronic disease? With the abolition of the baths public health must undoubtedly have declined.

The English Illustrated Magazine. No. 1. October, 1883. London: Macmillan and Co.

THERE is in this bright and clever new journal little which can legitimately come under our cognizance. There is a paper, by Mr. Grant Allen, entitled "The Dormouse at Home," which is so good a specimen of the author's manner of treating natural history subjects that a signature was scarcely necessary. Mr. Allen views the dormouse as a "central meeting-place whence all the radiating threads of the rodent pedigree diverge in the various directions of the rats, the mice, the squirrels, the marmots, the prairie dogs, and even the beavers."

"The Supernatural Experiences of Patsy Cong" is a tribute to the spiritualistic tendencies of the present day, but the strange occurrences described are left unexplained.

"Oysters and the Oyster Question," by an Inspector of Fisheries, is the first portion of a Lecture delivered at the Royal Institution in May last.

The Mason College Magazine. October, 1883. Birmingham: Cornish Bros.

WE are glad to find this bright little magazine reappearing after its summer recess. We notice a humorous article entitled "Robinson Crusoe, B.Sc., an Autobiography." Here those acquainted with local circumstances will doubtless be able to find more than meets the eye of the stranger.

A Member of the Natural History Society is credited with the following invocation:—

"O Sancte Herberte
Lucem da nobis
Rex philosophorum
Dux syntheticorum
In sæcula sæculorum
Lucem da nobis!"

"Vox Clamantis in Deserto" gives a list of miscellaneous requirements, among which we perceive, with satisfaction not unmingled with amusement, "A Society for the Liberation of Physiology from Tait Patronage and Control." Decidedly necessary, as the "patron and controller" is evidently impenitent.

A New Departure in Medical Electricity. By S. A. Mortimore Foote. Morton and Burt, Printers, Edgware Road.

From this little work we extract the following passage:—"I assert that *Electricity acting on flesh deprived of blood or fluid is a deadly poison. This is a very strong statement. Bring it to the test of experiment.* Nothing is easier. The writer would not dare to try it on his own person, so confident is he that the statement is perfectly true. Pass a piece of tape or string round a finger so as to press backwards all the fluids in the vessels. Then apply to the *bloodless flesh* a very feeble current, say from one cell, for a fraction of a second, and note the blood poisoning that ensues, and I venture to assert it will not invite repetition. Mind, this is not a theory. Everyone can test it at his own cost. *This I claim as my great discovery.*" (The italics are the author's own.)

We are not going, in comment, to assert what might or might not be the consequence of applying an electric current to "flesh deprived of blood or fluid." We have never made the experiment. Nor would it be at all easy. A ligature applied to the finger greatly checks the circulation, but it does not expel the fluids from the vessels. If the author doubts this statement let him tie a tape tightly round a finger, and then plunge a needle into the flesh below the ligature. He will find that it is by no means "deprived of blood or fluid." We do not give any opinion as to the results of applying an electric current to the extremity of a finger thus tied. They may possibly be disastrous; but in any case they cannot be due to the absence of fluid.

Mr. Foote's contention that electricity is often ignorantly applied no one can gainsay. The medical electrician is too often a quack of a very dangerous grade, and, if not altogether ignorant of electrical science, is often utterly unacquainted with physiology.

CORRESPONDENCE.

*** The Editor does not hold himself responsible for statements of facts or opinions expressed in Correspondence, or in Articles bearing the signature of their respective authors.

THE STRUGGLE FOR EXISTENCE.

To the Editor of the Journal of Science.

SIR,—Possibly the subjoined demonstration, that excessive competition in any sphere tends to frustrate its own ends, may be novel to some of your readers.

Let us suppose a large public building—church, theatre, lecture-room, or what you please—full of people. When the proceedings are at an end it will be quietly and quickly emptied. But suppose that each person, on entering, sees an announcement that the first fifty persons who make their exit after the end of the meeting shall receive a sovereign each, the next hundred half a sovereign, and the next—say two hundred—five shillings each. What will be the result? There will be a severe struggle, and, independent of damage to life and limb, the building will probably take twice as long to be cleared as under ordinary circumstances.

Now let us suppose the competition yet intensified: let the public on entering find an announcement, issued by some competent authority, that the last hundred or two hundred who issue from the place will be liable to heavy penalties, fine, or imprisonment. The struggle will become desperate, numbers will be trodden under foot, and the hall will not be emptied in four- or fivefold the usual time.

It may be said that such cases are entirely imaginary, and that we know not what would happen. This reply is founded on an error. Only a few months have passed since the offer of a few trifling toys allured a couple of hundred children to their death. And the effect of a terror behind the multitude was shown a few years ago at the cathedral of Santiago, where but a few of an immense throng of worshippers ever succeeded in making their exit at all. Can the meaning of these instances fail to be understood?—I am, &c.,

G. C.

PAYMENT BY RESULTS.

To the Editor of the Journal of Science.

SIR,—I have been much edified with Mr. Galloway's suggestion in your last issue, that the permanent officials of the Science and Art Deparment, as well as the Science teachers, should be paid by "results." If anyone asks what results are to be considered satisfactory, I should say the decrease of the foreign designers, chemists, engineers, &c., in our manufactories, and their substitution by natives. Did I see any movement in this direction I should feel convinced that the Department was at any rate moving in the right direction.

I think a return of the number of aliens filling places of trust in our industrial establishments would be a very instructive document, and would throw no little light on the question of technical education. Perhaps some Irish M.P. might move for such a return if no Englishman dare.—I am, &c.,

INCOLA.

NOTES.

Dr. T. S. Hunt, F.R.S., brought forward at the late meeting of the American Association a new classification of the Sciences. Under the head *Mineral Physiography* he includes Descriptive and Systematic Mineralogy, Geognosy, Geography, and Descriptive Astronomy. Under *Mineral Physiology* rank Physics, Chemistry, Geogeny, and Theoretical Astronomy. In like manner the Sciences of Organic Nature are divided into Biophysiography and Biophysiology, the former of which heads comprises Organography, Descriptive and Systematic Botany, and Zoology, whilst the latter embraces Biotics, Organogeny, Morphology, Physiological Botany, and Zoology.

Dr. C. C. Abbott ("Science"), in a very interesting paper on the Intelligence of Birds, records that he "girdled" the branches of an alder in which a summer warbler (*Dendræca æstiva*) and a white-eyed vireo (*Vireo novaboracensis*) had built their nests. The leaves consequently withered, and the nests were at once abandoned. But in a similar experiment where the nest contained young birds, the parents, though annoyed at the exposure, remained. He placed some short pieces of woollen yarn—red, yellow, purple, green, and grey—near the half-built nest of a Baltimore oriole; the birds made use of the grey yarns and a few of the purple when the nest was nearly complete, but left the red, yellow, and green yarns undisturbed.

Prof. E. D. Cope ("Science") has discovered, in the Eocene, an ungulated animal with carnivorous jaws.

We are happy to see that a serious movement is being made to establish a marine station for scientific, and especially biological research, at Granton, near Edinburgh.

The results of Prof. Nordenskiöld's expedition into the interior of Greenland must convince the world of the essential unfruitfulness of Arctic exploration. We might indeed, were the ice removed, find an interesting fossil fauna and flora; but how is this to be done?

Prof. E. D. Cope's paper on the Evidence of Evolution, as found in the "History of Extinct Mammalia," is, and was meant to be, a telling answer to Principal J. W. Dawson's anti-evolutionist presidential address.

"Science" characterises the climate of Minnesota by saying that "cranberries and rheumatism abound."

According to the "Revue Spirite" charges are brought against Prof. Mendelejeff, and certain of his colleagues at the University of St. Petersburg, of having smothered an enquiry into the truth or falsehood of Spiritualism, and shown bad feeling and bad faith.

Mr. J. Chatin has examined the apical club of the antennæ of *Vanessa Io*. It is covered with minute fossæ, narrower at the orifice and widening within, and having at their bottom the so-called *olfactory* rods, which vary in number from one to four in each fossa.

At the late meeting of the British Association Mr. Francis Galton presented an interesting Report on the Federation of the Local Scientific Societies.

We learn from a medical contemporary that a prominent anti-vaccinationist has committed suicide, as a sequel to the death of his wife and of three of his children from smallpox.

MM. Olivier and Richet ("Comptes Rendus") have established the mobility of the microbia found in the lymph of fishes, thus distinguishing them from a new histological element which they have discovered in the same medium.

Prof. E. Ray Lankester, in his Presidential Address delivered before the Biological Section of the British Association, pleaded urgently for the establishment of laboratories or stations for biological research in England. We trust that his plea may not prove in vain. But of this elsewhere.

We find in "Light" the following most deplorable comment upon Prof. E. R. Lankester's recent plea for the establishment of laboratories for biological research:—"Professor Lankester, of Bow-street notoriety in connection with the case of Dr. Slade, pleads for 'the Endowment of Research,' which appears to be that he and such as he should be subsidised by the State, such people being generally understood to be in search of knowledge, but not bound to teach it, or to produce results! But Professor Lankester was always very modest!" Prof. Lankester and "such as he" have already furnished very valuable results, and would do more if they had the scope afforded them. To think that the scientific discoverer should spend his time in teaching is as unreasonable as to expect the manufacturer to retail his own products.

The Java catastrophe seems to many persons a confirmation of the alleged disappearance of Atlantis.

An important new work by Robert Hudson Graham, C.E., will be shortly issued by Messrs. Crosby Lockwood and Co., London, entitled "Graphic and Analytic Statics in Theory and Comparison;" their practical application to the Treatment of Stresses in

Roofs, Girders, Bridges, Arches, Piers, and other Frameworks; with a chapter on Wind Pressures, and a number of diagrams and plates to scale, with examples—many taken from existing structures. The same publishers also announce for immediate publication, "The Art of Soap-making," a Practical Handbook of the Manufacture of Hard and Soft Soaps, Toilet Soaps, &c., by Alexander Watt; "The Engineers' and Shipowners' Coal Tables," by Nelson Foley, author of "The Engineer's Office Book of Boiler Construction": and the following works in their popular "Weale's Rudimentary Series":—"Farm Buildings," a Treatise on the Buildings necessary for various kinds of Farms, and their Arrangement and Construction, with Plans and Estimates, by Professor John Scott (being the fourth volume of Scott's "Farm Engineering Text-Books"); and a revised and enlarged edition of "Sanitary Work in the Smaller Towns and Villages," by Charles Slagg, A.M. Inst. C.E.

A journal is now published in Germany devoted to the study of Fungi, from a botanical, physiological, and economic point of view.

Mr. C. H. Fernald, of the Orono State College ("American Naturalist"), mentions that a horse went alone, and without the knowledge of his owner, to a blacksmith's forge to have one of his shoes rectified.

Says an ultra-heretical journal, "Darwin was a laborious physicist, but no thinker to speak of. Taxonomy is not thought." We ventured to foretell, some years ago, that the great naturalist would before long fall into disgrace among "advanced thinkers."

Mr. W. N. Lockington ("American Naturalist") ably combats the paradox of Prof. Minot that man is not the highest animal.

Mr. J. S. Kingsley, in the same journal, questions the validity of the group Arthropoda, and points out important heterologies of structure between its two component sub-groups, Crustacea and Tracheata.

The editors of the same journal say judiciously, concerning certain troublesome neologisms, "What theologians are pleased to call the 'natural,' man rightfully rebels against an overstrung nomenclature."

A very large portion of the world's annual yield of platinum is obtained from the Upper San Juan.

M. J. Delauney ("Comptes Rendus") proposes the following law on the occurrence of earthquakes, &c.:—"The majority of the phenomena of cosmic and terrestrial meteorology, and in particular the great seïsmic tempests, seem to take place when the larger planets pass certain longitudes, especially 135° and 265°."

Evolution does not appear to have found grace in the sight of the Church Congress. It was discussed by the Bishop of Carlisle, Mr. Aubrey Moore, Prof. Pritchard, Bishop Perry, Prof. Engstrom, and Mr. W. D. Gounod, who are said to have been "frequently applauded."

A tribe of Indians having decided tails, 6 to 8 inches long, is said to have been discovered in Paraguay. Should this announcement prove true we must protest against them being paraded as "the missing link," since the anthropoid apes are tailless,

The Municipality of Lisbon has decided that cremation is permissible under ordinary circumstances, but must be compulsatory in case of epidemics.

The French Association for the Advancement of Science devotes a large share of its attention to economic and engineering questions, thus savouring strongly of politics and of finance.

We greatly regret to learn the death of the illustrious Swiss palæontologist, Oswald Heer.

The brain of Carey is said to have had the unusual weight of 63 ounces.

The "Medical Press and Circular," criticising Dr. Clifford Allbutt's speech at the amalgamation of the Leeds School of Medicine with the Yorkshire College of Science, justly remarks that on the Vivisection question the medical profession "blustered a good deal too little; had they spoken out boldly, declined a deceptive compromise, and taken every possible opportunity of exposing the misrepresentations and sophistries of the Anti-Vivisection fanatics, the agitation would have been stamped out by this time."

Mr. Bradford Torrey ("Science") disproves, from actual observation, the assertion of the Duke of Argyll that no bird (humming-bird) ever flies backwards.

An effort is being made to place the American signal or meteorological service in the hands of civilians. Its present military organisation is open to not a few objections.

According to the "Posener Zeitung" a workman was arrested in the Sapieha-Platz, Posen, "for having in his possession three bottles of living ants, which he was offering for sale."

Veth and Van Hasselt ("Deutsch. Geogr. Blätter.") have published an account of their ascent of Indrapura, the loftiest of the Sumatran volcanoes. The height of the mountain is 3700 metres (about 11,500 feet), and the temperature at the summit 8° C. The region of large trees comes to an end about 2500 metres.

Mr. G. Jinman, F.R.G.S., in a circular, maintains that storms are periodic in their arrival, and are governed by perfect laws. He rejects the circular or spiral theory, and insists—in opposition to Mr. Scott, of the Meteorological Office—that storms give more than forty-eight hours warning of their approach. The importance of the subject surely warrants a full and fair enquiry.

Mr. C. S. Mixter ("Science") gives reasons for thinking that the relative increase of the negro and negroid population of the United States is not so rapid as it has been feared.

MM. Cornil and Berlioz ("Comptes Rendus") show that the bacilli of the jequirity produce serious disease if introduced into the animal system. Frogs and fishes succumb more readily than the small Mammalia.

There is difference of opinion as to whether birds leave the neighbourhood during an epidemic of cholera. The discussion so far consists merely of flat assertion and flat denial.

"Science," in an able article on "National Traits in Science," writes:—"Very noteworthy is the fertility of the English in generalisation: this is with them a process of individual effort quite unlike the German democratic method of generalising by the accumulations of many. Is it too much to say that the English and Scotch are the Greeks of modern philosophy?"

Dr. Jackson, whilst hunting in the jungle near Pachmarree, India, was attacked by hornets, which stung him so seriously that he died within two days.

We regret to find that we have omitted to record the death of Dr. Hermann Müller, one of the most able and successful coadjutors of Charles Darwin.

The "Medical Press and Circular" speaks of Prof. Huxley's "ready acquiescence in existing evils." Prof. Huxley is, however, reported as saying—"If it should so happen that a Claude Bernard or a Ludwig should turn up in London among you gentlemen, at the present time, I really do not know what we should do with him; I do not think we could turn him to account. I think we should have to export him to Germany or France."

Dr. A. L. Child ("Kansas Review of Science") gives abundant evidence that the concentric rings of trees are no trustworthy indication of their age.

Prof. S. A. Forbes ("Science") is investigating the epidemic among caterpillars known as "Schlaffsucht," and has traced it to Micrococci.

The October number of the "Journal of the Royal Microscopical Society" contains a translation of a paper, by L. Olivier, on "Practical Processes in Vegetable Histology" (Rev. Sci. Nat.,

i., 1882, pp. 436 to 454; ii., 1882, pp. 71 to 91). Most of the processes used in the examination of animal tissues have been brought to great perfection; the same elaborate methods do not seem hitherto to have been applied to the study of vegetable structures; in fact, the subject is rather behindhand. The following subjects are discussed:—Clarification, Fixation of Forms, Contraction, Precipitation and Crystallisation, Dissolution and Destruction, Colouring, Preservation. A full account is given of the various reagents employed, and manner of observing tissues under such treatment. The Anti-Vivisectionists may probably object to experiments on living tissues, having for their object the induction of contraction in the cell-contents, and the staining of living organisms, as was done by Certes, for exhibition to the members of the Zoological Society of France: probably English botanists may ere long be compelled to *boil* their plants before experimenting on them. The colours available for this purpose are aqueous solutions of cyanine and aniline brown (Bismarck brown). "These results are important: by taking these into consideration in the future we may be able to study, on the living subject, the phenomena of conjugation and reproduction in the Algæ and Infusoria, instead of being, as hitherto, confined to the study of the organisms killed in different stages of their evolution." This process will probably give good results with some of the lower Algæ, which have hitherto involved much tedious observation. With respect to mounting in Canada balsam, exception must be taken to the statement "that, by reason of the difference of the refractive powers, it is preferable for the preservation of diatoms." Mr. J. W. Stephenson has shown that its refractive index is too close to that of diatomaceous silex, and that media of higher refractive index can be used with the result of producing much greater visibility ("Journal of Science," 1881 and 1882). The references to authorities are very numerous, but, after the usual custom of French and German authors, the existence of any English observers is studiously ignored. The paper is a valuable one, and might have remained unknown to the majority of English students but for the enterprise of the Royal Microscopical Society.

The same number also contains an exhaustive and beautifully illustrated paper, by C. T. Hudson, LL.D., F.R.M.S., "On *Asplanchna Ebbesbornii*, a New Rotifer." This is a valuable contribution to Science. It is to be hoped that Dr. Hudson's monograph may soon appear, as information respecting the Rotiferæ is at present scattered through the periodical literature of many years.